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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XII. No. 138. JUNE, 1931. PRICE 1s. NET

FRAGMENT OF A GLASS DRINKING CUP.
From the Romano-British City at Colchester.
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MISCELLANEOUS ANNOUNCEMENTS

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ST. PAUL'S GIRLS' SCHOOL, BROOK-GREEN, HAMMERSMITH, W.6. The NEXT EXAMINATION for FOUNDATION SCHOLARSHIPS will take place on TUESDAY, WEDNESDAY, and THURSDAY, July 7 8, 9. These scholarships exempt the holders from payment of tuition fees. Application should be made to the High Mistress at the School. The last day for the registration of candidates is Saturday, June 20th.

DRAUGHTSMAN (20 years' experience) and self-taught Physist, *appeals* to Scientist for short interview to enquire how the "Conservation Law" can be applied to the Theory of "A Machine to Overcome Gravity," which he has evolved, and which is extremely perplexing. Box A12, "Discovery," 154 Fleet Street, London, E.C.4.

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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager.

Offices: Bouverie House, Fleet Street, London, E.C.4. (Closed on Saturday.)

Telephone City 0244. Telegrams: Benbrolish, Fleet, London.

Annual Subscriptions 12*s.* 6*d.* post free anywhere in the world. Single numbers, 1*s.* net; single back numbers more than two years old, 1*s.* 6*d.* net: postage 2*d.*

Binding cases, price 2*s.* 6*d.* net each; postage 6*d.*

Notes of the Month.

The decision to retain the airship R 100 for experimental purposes is a welcome assurance that the experience already gained in airship matters will not be lost, and the choice of a middle course between abandoning airships entirely and pursuing an ambitious programme of development has met with general approval. While spectacular achievements must not be looked for, we shall at least not lag behind other countries in exploring the possibilities of future development. There is still a wide division of opinion, and the Government's policy has been strongly criticized on the score of expense, but the value to science of further research must surely be recognized. One of the chief difficulties in the way of future progress in this country is the scarcity of helium gas, and the experts are faced at the outset with the dual problem of finding more abundant supplies of the gas and a more economical means of purification. One point is clear: if real headway is to be made, airship problems must be regarded as international; and the decision to pursue experimental work in this country will at least enable us to contribute our share to world progress in this important work.

* * * * *

It is evident from the correspondence in the Press which has arisen out of the recent Exhibition of Persian Art, that there is a strong and influential body of opinion in favour of a museum solely devoted to Asiatic or Oriental art. When this proposal was discussed at a meeting at India House, it received the support not only of the principal institutions and learned societies interested in Oriental studies but also of museum officials, who are probably best qualified to speak of the disadvantages under which students have at present to pursue their work. There are probably few who are fully acquainted with the riches of the national collections in objects of Oriental art; this is due partly to lack of space for their adequate display and partly to their distribution between several departments in two institutions, one in South Kensington and the other in Bloomsbury. While a strong case has been made out for the formation of a separate and distinct collection, in accordance with the recommendation of the Royal Commission on Natural Museums, there is danger that certain broader aspects of the problem may be overlooked. The need of London, as the central city and one of the chief academic centres of the Empire, is not merely for a museum of Oriental art in the sense of *fine art*; the essential requirement is a collection fully illustrative of the life and culture, both ancient and modern, of Asiatic peoples. It is to be hoped that this important side of the question will be remembered when concrete proposals are under consideration.

* * * * *

The daylight transmission of street scenes is the latest development in the field of television. Hitherto transmissions have, of course, been confined to subjects arranged in the studio. Although television by daylight was demonstrated in the Baird laboratories nearly two years ago, it has not before been possible to transmit scenes from everyday life under normal daylight conditions. This has been made possible by the perfection of an apparatus which differs in certain respects from that employed in the studio. In place of the customary travelling spot of light, there is a large drum with mirrors fixed to its circumference. This revolves at a high speed and projects a succession of images of the scene upon a photo-electric cell. The cell converts the moving images into a varying electric current which is transmitted by wire or wireless to the receiving set, where

it is reproduced in the ordinary way. Arrangements are now being made whereby outdoor scenes will be included in the programmes sent out by the Baird company through the B.B.C.

* * * * *

All lovers of books will welcome the formation of a society under the chairmanship of Sir Frederic Kenyon to be known as the Friends of the National Libraries. During recent years increasing numbers of our greatest treasures have left this country, and the aim of the society is to keep a watchful eye on all opportunities for securing important documents and manuscripts as they come into the market. While the fostering of the three great national libraries will be one of the foremost aims, the society hopes to extend its scope to university, municipal and other libraries. The formation of this society appropriately follows the action of the State in increasing the grant towards the greatest of our national libraries, the British Museum, and should do much to stimulate public interest in rare manuscripts. In the account of his work for the famous library which he founded, Bodley numbered among its requirements "a very great store of friends to further the design" and "purse-ability to go through with the charge." The Friends of the National Libraries may be relied upon to see that these requirements are met.

* * * * *

Tradesmen's accounts and school textbooks of over four thousand years ago are among the relics which Mr. Leonard Woolley has brought to London from the city of Ur of the Chaldees. The "books" are in the form of clay bricks and some are as much as eighteen inches wide. Mr. Woolley expects to draw some interesting conclusions from the tablets concerning the domestic life of Ur; it is hoped, in fact, to compile a complete directory of the city dating from about 2000 B.C. The records have not yet been studied closely, and it is not unlikely that even more interesting records of everyday life in Ur will be revealed. The complete collection, contained in thirty large packing cases, has been brought to the British Museum for study, but half of it is destined for the Gertrude Bell Museum at Baghdad, and a quarter for the Museum of Pennsylvania University.

* * * * *

By the time this issue of *Discovery* appears the new zoological park at Whipsnade will be open to the public. The park will not, of course, be complete, for that will take many years; but considerable progress has already been made. A water supply has been installed in what hitherto has been a waterless area, and large paddocks have been constructed and provided with water and shelters for the animals. It is the intention to make the park a sanctuary for British wild flowers and birds as well as a home for animals, and all wild flowers, trees and shrubs natural to the locality have been protected and encouraged. Thousands of young trees have already been planted in belts so as to form a woodland background to the paddocks. Within a few years, this arrangement should add considerably to the charm of the gardens. At the annual meeting of the Zoological Society, the Duke of Bedford explained that progress in the collection of animals has necessarily been slow, for the cost of providing barriers which will be safe and at the same time sightly is obviously considerable. The ultimate intention is that deep ditches shall form the barriers, thus avoiding unsightly iron bars as much as possible. There is already a large collection of birds and beasts at Whipsnade in readiness for the opening day.

* * * * *

The excavations at Gaza in Palestine by the British School of Archaeology in Egypt, under Sir Flinders Petrie, have been productive of important results during the past season. The site of the ancient city has been discovered, and the remains found in the upper strata excavated indicate that it was abandoned about 2000 B.C. The site of the city is about twenty-eight acres in extent; and the well-preserved walls of yellow clay bricks were found at only about eight inches below the surface. Some eighty rooms have been opened up; these belong to houses of which the exact number has not yet been ascertained. From the evidence of the names of kings found on certain objects, it would appear that the city was in the occupation of the Hyksos. Sir Flinders Petrie regards the discovery as immensely important, in view of the fact that this is the first city of the so-called Shepherd Kings to be brought to light in Palestine.

* * * * *

The interesting suggestion that the occurrence of the gorilla and chimpanzee in the same neighbourhoods of the Congo forests is a significant factor in the problem of man's origin is made by Professor Raymond Dart, who has recently returned from investigating the habits of the gorilla in the sanctuary reserved for them by the King of the Belgians. Many interesting anthropological facts are disclosed by Professor Dart. The gorillas in the National Park are of both black and red varieties, and each appears to keep to its own area. It is believed that investigation into the causes of this separation is likely to throw valuable light on the beginning of man's division into great national groups.

Excavating the City of Cymbeline.

By Christopher Hawkes, B.A.

Assistant Keeper in the British Museum.

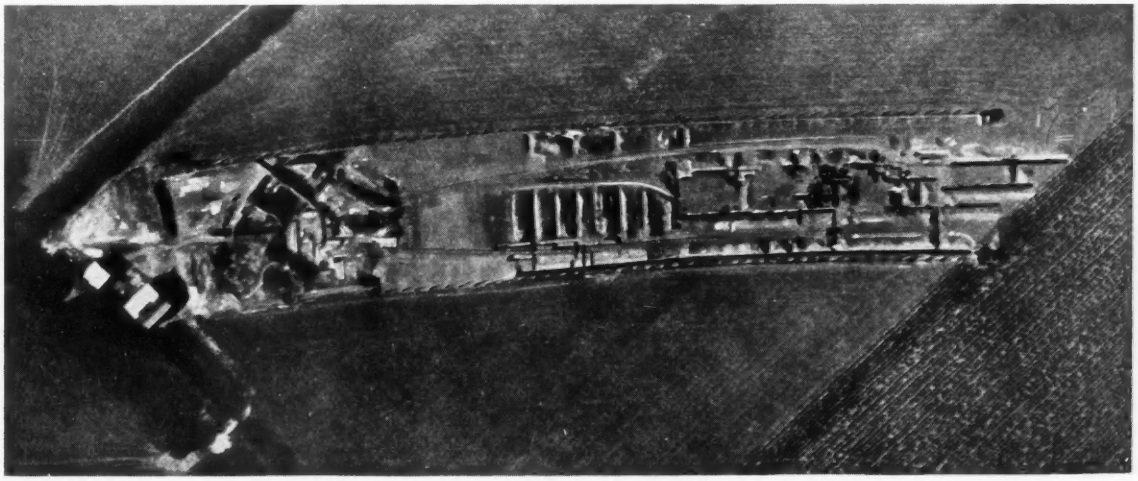
Last spring a new by-pass road threatened the site outside Colchester where stood the Celtic city of Camulodunum, the capital of Shakespeare's King Cymbeline. Excavations were immediately begun, and are continuing this year. This article is an outline of their results and of the future prospects of the work.

In the Christmas number of *Discovery* the excavator of Verulamium began his account of last summer's work by quoting a dozen "quaint and halting verses" which serve to epitomize the double interest drawing the visitor thither: the remains of a famous British and Roman city, and the pervading "atmosphere" of Baconian England. Round St. Albans, indeed, Francis Bacon comes much into one's mind, and the thought helps one to remember, in admiring the great ramparts of the Roman town, that the fascination of history, whether written or monumental, aroused in Baconian England one of its outstanding enthusiasms.

But the most potent reminders of this are no "quaint and halting verses": they are surely—if Baconians will permit the transition—the plays of Shakespeare; and the expression it finds in Shakespeare cannot be circumscribed by the critics' stiff divisions of "the histories" from "the tragedies," "the romances," and the rest. The legendary glories of the Kingdom of Britain live as truly in "Lear" and "Cymbeline" as does Plantagenet England in "the histories," for indeed they are not wholly legendary, as Shakespeare and the chroniclers he read so eagerly very well knew.

In "Cymbeline" at least the historical situation makes the whole framework for the weaving of the human interest, and the more we come to know of Britain on the eve of the Roman conquest, the clearer it becomes that Shakespeare, searching among the chroniclers' welter of fact and fiction for the outlines of the play he was conceiving, brought out the main features of it with the instinct of genius for truth. Between the sturdy British tradition of the men who fought with Caesar, and the powerful influences that streamed in on the next two generations from the Roman Empire of Augustus and his successors, we have a play to which the final invasion of Britain by Claudius forms only a historians' epilogue.

The century from Caesar to Claudius was a crucial one, and now that we can supplement the historians with the study of coins, inscriptions, and all the mass of the archaeologist's humbler material, our knowledge of the names and policies of kings, and of the effects of the impact of Roman upon British civilization,



THE CITY OF CYMBELINE FROM THE AIR.
The excavated strip of the Celtic city at Colchester photographed during the course of the work.

is growing rapidly. Thus, while Shakespeare's picture is illumined ever more clearly, we can for our own purposes fill out ours with a new wealth of absorbing detail.

In particular, we can give our "Cymbeline" a new scene, and instead of the mythical "Lud's town" in which Shakespeare with good London pride believed, we can seat the king in his own capital. It stood on the rising ground just to the west of the town of Colchester in Essex, and its name was Camulodunum. Here for half a century at any rate before its capture by Claudius' legions in the year 43 was the metropolis of south-eastern Britain, defended, it seems, on the west by a series of great earthworks; here the king struck his famous coinage, here the civilization of his people, whether of Belgic or more ancient stock, rose to its highest as it rose to meet the influx of the culture of the Roman Empire.

THE REMAINS OF A CELTIC HOUSE.

The irregularly shaped area of the untrodden earth floor has been cleared of the overlying accumulation of rubbish, and in the centre is seen the malodorous cesspit which occupied the middle of the floor.

Camulodunum has thus an importance impossible to parallel elsewhere, and there is another fact about it which makes it even more attractive to the archaeologist than its literary associations. Within seven years of the Roman invasion it was evacuated, and the new foundation of the "Colonia Victrix"—in fact and in name the symbol of Imperial domination—rose on a virgin site, that of modern Colchester nearly a mile away. Thanks to this favourite stroke of the Government's "native policy," the overlying débris of a Roman provincial city are not present to bury and dislocate the remains of its Celtic predecessor; and while the new colony was the first objective of the famous rebellion of Boudicca, the intrusion of one or two Roman rubbish-pits and some small amount of Roman levelling for the plough are the worst that the old Camulodunum has had to suffer from the first to the twentieth century.

The events of the past few years, however, have made it clear that no ancient site on the outskirts of an expanding modern town can be considered safe without special protection, and just as Newport has threatened to overspread the Roman fortress at Caerleon, so Colchester is threatening to absorb its parent site. All through the nineteenth century isolated discoveries testified to its archaeological wealth, and the excavation in 1924 of the great tumulus to the south-west of it revealed a Celtic burial of great magnificence which may even be that of Cymbeline himself. But measures to safeguard the land were never taken, and present-day "development" is thus an imminent danger.

In the spring of last year it became suddenly known that under the sanction of the Ministry of Transport a Colchester by-pass road, eighty feet wide, was immediately to be begun, and as the plan here reproduced shows, it was to pass right across the Celtic site, as well as over a Roman cemetery and kilns north of the Colne. Plainly the only thing to do was to excavate the whole long slice of proscribed land before the road-builders began work on it; the Colchester Excavation Committee was quickly formed under the presidency of Annie, Viscountess Cowdray, High Steward of Colchester, and the chairmanship of the President of the Society of Antiquaries, Mr. C. R. Peers, and an urgent appeal for funds was issued. Happily the response was such as to enable excavations to begin in June and last until the autumn. The Colchester Corporation authorities readily co-operated, and under the general direction of Mr. J. P. Bushe-Fox, the present writer and Mr. J. N. L. Myres supervised the work with Mr. M. R. Hull of the Colchester and Essex Museum.

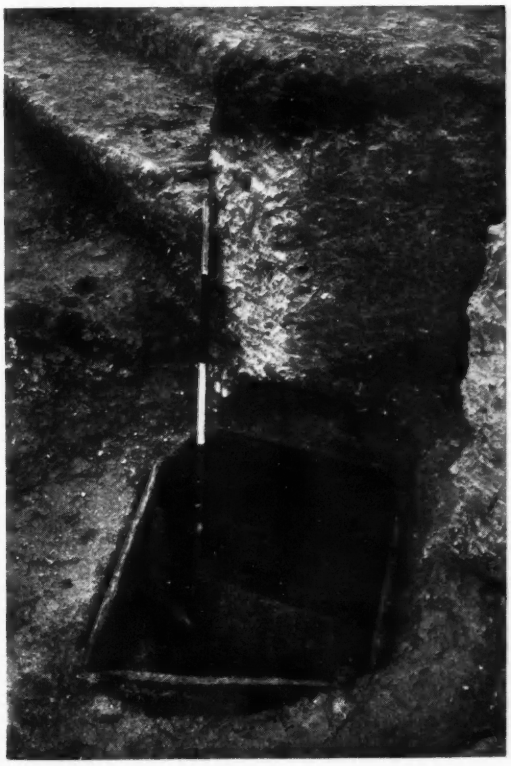
Four main sites were examined—one, at Mercer's Farm, had formed part of a Roman cemetery, and gave little trouble, but the next, at Sheepen Farm, proved to be in a thickly occupied and extremely interesting part of the Celtic city; this was the main scene of operations. The Committee's policy of

exploring everything on the line of the new road had also unexpectedly to be extended to include work on an adjoining field of ten acres, acquired by the Essex County Council during the summer for immediate conversion into playing-fields. The exigencies of gravel-working near Sheepen Farm made digging at a fourth site necessary, and in the end much of the work on the line of the by-pass had to be held over for 1931.

By the time this article appears all will be over there, for on 1st June the Committee's time-limit expires, and it is hoped that Mr. Hull will have completed the campaign he began, supported by funds raised through a second circulated appeal, in the early spring. Thereafter the piecemeal exploring of the land between Sheepen Farm and the Lexden Road must be carried forward, for when the by-pass is opened, " development " here will inevitably follow, and the excavator must do his best to secure as long a start as possible, for his work, if it is to be thorough, is of necessity slow and expensive. But there lies the heart of the Celtic town, and the Committee is pledged, if it can continue to obtain financial support, to rescue everything it can from the destruction that otherwise will sooner or later overtake it. Meanwhile it may be of interest to summarize the results that have so far been achieved.

The main site examined, on Sheepen Farm, lies not far from the river at the foot of the hill running up towards the Lexden Road. It must be fairly near the northern edge of the town, for much of the strip between it and the river is uninhabitable water-meadow, but evidence has appeared everywhere of intensive occupation. The structural remains are often hard to interpret at a glance, for it seems that the Celts did not build in stone, and in this quarter of the town at least their habitations were distinctly primitive in type. An accompanying photograph shows the appearance of one of the Celtic houses after excavation, lying between the two trial trenches that run across the foreground and the background. The irregularly shaped area of its trodden earth floor has been cleared of its overlying accumulation of rubbish; round the edge of it, deposits of burned clay daub and the post-holes that are occasionally recognizable mark the line of the wattle-and-daub walls, supported on timber framing, that formed the structure of the dwelling. In the centre, immediately in front of the transverse section trench, is seen the dark and malodorous cesspit which occupied the middle of the floor. In many cases the houses were drained by ditches, which often run for quite long distances across the site, but in others again the whole dwelling is in fact one large pit, in which, after the regular prehistoric manner, the floor was made up afresh with clay over the accumulated rubbish when it had become intolerable.

The success of the excavations from the scientific point of view, indeed, largely depends on the distinguishing and correct interpretation of successive strata and the sequence of deposits in such cases, and as the site was at first without any general plan, and underwent various alterations in which house-sites, open hearths, pits and ditches of different types were constantly being made to overlap each other, this work is often far from easy. For instance, in one case a timber-lined well—one of three found in all, in fine preservation — was discovered at the edge of a house, whose floor is represented by the shelf cut in the ground to the left of the surveying pole in the photograph. Later, both house and well were given up, the ground was made up over them, and a new house-floor was laid at a much higher level, which shows dark at the top of the picture.



A TIMBER-LINED WELL.
The lining is formed of oak corner-uprights with transverse planks between. Behind are seen the earthen house floors described in the text.

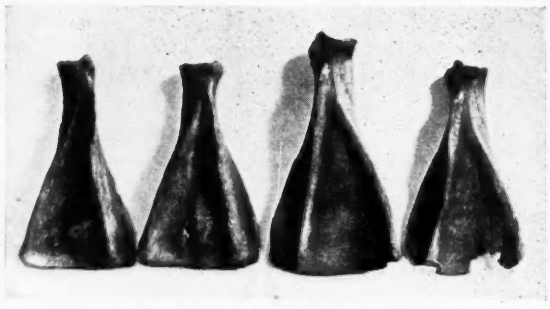
There was evidence, indeed, that the reconstruction here was part

of a general plan of reconditioning this portion of the site, which was undertaken some time after the middle of Cymbeline's reign. This depends on the correlation of strata all over the adjoining areas with those in a great thirty-foot ditch or channel which was found cutting right across the site in a northerly direction. In the course of excavation it displayed in a striking manner the successive layers that record its history, first as an open channel, getting gradually choked with black mud and refuse—including thousands of the shells of the famous local oysters—and then filled in and made up to the surface for fresh habitation-floors at two successive levels.

So perhaps Cymbeline made an early effort towards town-planning in his capital. Certainly, as it first grew up, the town, as a town, seems to have been primitive enough : what distinguishes it from earlier settlements is rather its huge size than any high constructional standard. For instance, the great ditch had evidently been dug with primitive shovels made of the blade bones of oxen, for thirty or forty of these crude tools—the type was in use as long ago as the Stone Age—were found discarded in a heap on the gravel bottom : some are shown in the photograph.

By contrast, the pottery and metalwork is of an amazingly high standard. Iron is seldom well preserved, for the site is damp, but enough bronze has survived to show excellent craftsmanship in making brooches and other ornaments and such products as harness-fittings, and to indicate what the pottery shows more overwhelmingly still, the enormous extent of Roman commercial influence in the years preceding the conquest. Half the brooches found are of recognized Gaulish types, and as Gaulish and Roman Republican and early Imperial coins appear along with Cymbeline's own, a great

TYPES OF POTTERY.
The four vessels on the left are imported wares, with native British pottery on the right. They are a striking contrast with the crude shovels above.



PRIMITIVE SHOVELS.
The great ditch had evidently been dug with primitive shovels made from the blade bones of oxen, a heap of which was found discarded on the gravel bottom.

volume of trade across the Narrow Seas is attested. The pottery evidence is remarkable ; the crude hand-made pots of earlier Celtic times persist, though they are outnumbered by the finer native wares turned on the wheel (introduced about a century before this time to Britain), which with their graceful profiles and cordon and groove decoration testify to the native potters' taste and skill.

But along with great quantities of the native wares of all kinds, every part of the site yielded in abundance the products of wholly different industries—those of contemporary Italy, Gaul, and the Rhineland. It is plain that from the western provinces of the Empire, and also from beyond the Alps, pottery was exported on a large scale for the British market, and that these fine foreign wares were used by all sections of the population—at Camulodunum at least—along with the products of the native industry. The leading Italian fabric of the period is the red-glazed pottery of Arretium (Arezzo in Tuscany), and in the twenties of the first century a similar industry sprang up to compete with it in southern Gaul, by beginning to turn out the glazed ware, afterwards so familiar on Romano-British sites, that we usually know as " Samian." Both Arretine and the earliest " Samian " pottery are plentiful, and still more so are the polished red and black wares made largely in imitation of them in northern Gaul and the Rhineland at the same time. There is also a whole range of handled jugs, ornamented bowls, jars, and beakers, and heavy amphorae and mortars from the Roman provincial potteries. A photograph shows a small selection of the pottery types, imported Roman examples on the left, and native British on the right.

On the playing-field area explored near by, similar results were obtained, and the two portions of the site together have yielded a striking picture of a thickly-populated and peaceful commercial and industrial town, in which old barbarian traditions

FRAGMENTS OF THE GLADIATOR CUP.
Among the stray relics of Romano-British life which the site has yielded are the fragments of a moulded glass cup, decorated with the combats of gladiators.

appear side by side with the steady advances of new civilization from abroad.

It may be that the huddled mass of primitive dwellings—some mere hovels and none more than tolerable huts—will give place to more ambitious structures as the excavations approach nearer the heart of the city, where the king himself must have resided. It may be that tools, for instance, more serviceable than bone shovels will be found; for indeed the purely native element in the culture of the place was far from wholly primitive, as the evidences already obtained of pottery and metal-working show. Again, there is Cymbeline's mint to be discovered, which issued coinage of no mean order. But the notable thing about this latest Celtic civilization is its penetration by Roman influence. By this the story of Britain is seen to be like that of all other lands that became Roman provinces. The path of the legions was opened up by trade. It was the enterprising Italian or Gallo-Roman merchant, always in quest of new markets across the military frontiers, who prepared the lands beyond them for submission to the "Roman peace." The pottery, glasswork and bronzework of Italy and the western provinces that reached Camulodunum for half a century before the armies of the conquest are thus significant guides to the trend of British history in that crucial period. They make it plain that when Cymbeline took the Latin "Rex" for his title, as his coins tell us, he was adopting the language of a civilization that was soaking ever more deeply into the people of his capital.

Such was Camulodunum up to the Roman conquest. We know from the historians that it was captured by the Expeditionary Force of A.D. 43, but no signs that it was sacked or burnt have yet been observed. Still, its capture clearly brought about various alterations, and though it is yet too early to attempt to say in detail what was done, it is significant that the gravel-pit site examined just south of Sheepen Farm has revealed a great ditch of military pattern running north by east across the hillside, which belongs unmistakably to the years of the conquest, and was filled in very soon afterwards. Certainly Roman troops must have lain here before being moved forward for the campaigns that ensued in the west and north, and it was at their departure that the new colony was founded to supersede the native city.

Thereafter it is beneath the streets and houses of Colchester itself that the materials for continuing the story must be sought; the eloquence of the old Camulodunum lies in its silence. But among the stray relics of Romano-British life one at least deserves notice here—the fragments of a moulded glass cup, decorated with the combats of gladiators. The names of these arena favourites appear in a frieze above the figures, and this echo of the characteristic Roman sport makes a striking symbol of the Imperial civilization, which, after influencing so powerfully the last years of native independence, came at last to strike its roots so deeply in our island. Camulodunum has indeed more to reveal than any other site in the country of

> "the Roman eagle,
> From south to west on wing soaring aloft,"

by virtue of its unique history as the city of

> "the radiant Cymbeline,
> Which shines here in the west."

THE GLADIATOR CUP RESTORED.
The names of the arena favourites of the day appear in a running frieze above the figures. The restoration of the vessel required much skill and patience.

A Critical Phase of Geological History.

By A. C. Seward, Sc.D., LL.D., F.R.S.
Professor of Botany in the University of Cambridge.

The author deals with one aspect of the Great Ice Age, namely, the effect upon contemporary vegetation of the Arctic conditions which prevailed in one part of the temperate zone some thousands of years ago.

THOUGH the events summarized in this article did not occur before our remote ancestors had crossed the ill-defined boundary between the higher mammals and the animals that are called man, they have no direct reference to the human side of pre-history and may be described as geological and botanical. Our retrospect will be practically confined to a few pages of the most recent chapter of geological history.

Ice-Sheets from the North.

Briefly stated, my intention is to convey to laymen a general impression of a certain aspect of the glacial period or great Ice Age, and to consider the effect upon contemporary vegetation of the invasion of temperate regions on both sides of the Atlantic by glaciers and ice-sheets from the frozen north. In Canada and the United States it is estimated that approximately four million square miles of the land were almost completely buried under ice. It is common knowledge that a large portion of the northern hemisphere, where glaciers are now unknown or confined to the upper reaches of Alpine valleys, was almost completely over-ridden by ice; the conditions were then much the same as they are in Greenland and on the continent of Antarctica at the present day.

Geologists know that the Ice Age, which came to an end on the eastern side of North America not many thousand years ago, was not the only episode of its kind in the history of the world. We speak of the great Ice Age as though it were unique, a single and unusual disturbance of the harmony of Nature; it is, however, well known to geologists that there was an even more widely spread glaciation in another part of the world when the earth was millions of years younger. The old-fashioned conception of a gradually cooling globe is no longer adequate as a guiding principle in the interpretation of geological evidence: since the earliest ages, which have left records available for us "afterthoughts of creation," there have been recurrent periods of relative repose alternating with periods of stress; periods in which parts of the earth's crust remained relatively stable; periods of upheaval and the building of mountains. The whole course of geological history may be described as a series of cycles. Evolution in the organic as in the inorganic world has taken its course since the dawn of life under conditions which, though fluctuating with rhythmic regularity, have not on the whole differed very widely from those at the present time.

When the stage was set for the last glacial period a large part of the northern hemisphere was several hundred feet higher in relation to sea-level than it is now. On a superficial view a map of the world as it was in pre-glacial days would seem to differ but little from the map with which we are familiar; though on closer inspection it would be seen that many small areas that are now islands were then parts of the mainland. The extent of the land was slightly greater and the shelving coasts were broader. In the days before the Ice Age, England was still united with the rest of Europe; a marshy plain occupied the more southern half of the North Sea and the great delta of the Rhine reached as far as the coast of East Anglia.

Remains of an Ancient Forest.

The events immediately preceding and during the early stages of the glacial period are clearly recorded, and may be conveniently studied on the east coast of England near Cromer in Norfolk and at neighbouring localities: at the lowest level of the beach left by the receding tide may be seen the remains of an ancient forest, the so-called Cromer forest-bed with drifted logs of wood and patches of an old soil. The scraps of plants obtained from this source indicate a climate in eastern England almost the same as it is now, though possibly a shade warmer, and a vegetation practically identical with that now growing in the district. Above the Cromer forest-bed is a layer of sediment known as the Arctic plant-bed because of the occurrence of fragments of the dwarf birch, Arctic willow and other stunted shrubs with flowering herbs that are now confined to Arctic lands or to the mountain tops of temperate regions.

Here we have proof of a change in climate and a consequential change in the vegetation. Above the

Arctic plant-bed in the Norfolk cliffs there is a thick mass of jumbled material known as boulder clay which affords unmistakable evidence of having been formed by the agency of moving ice. The first evidence of Arctic conditions in northern Europe was discovered rather more than seventy years ago, when pieces of a dwarf birch were found in the south-west of England. This led to many similar discoveries in other parts of Europe, clearly attesting a widespread Arctic climate. The botanical records demonstrate a fall in temperature from temperate to Arctic, and associated with the layers of peat and clay containing the fossil plants are thick accumulations of material—stiff clay full of ice-scratched boulders, sands and gravels—proving the former presence of great moving masses of ice.

The Nature of Drift.

It was Louis Agassiz who found the clue to the interpretation of the true nature and implication of the deposits that are now known as drift, that is, boulder clay, glacial sand and gravels and other deposits which over a wide stretch of North America and northern Europe bear eloquent testimony to some of the more recent finger-prints of Nature. Agassiz noticed that the Swiss glaciers and the milky streams issuing from their snouts are building up piles of rock-débris and layers of sediment agreeing in every detail with the superficial drift of regions that are now ice-free. As a glacier is slowly forced down a declivity by the increasing thrust of the mass of snow and ice behind it, which grows in amount faster than it melts, loose pieces of rock are caught up into its under-surface and blocks detached by the action of frost from the cliffs of the ice-filled valleys fall through crevasses and thus provide the glacier or ice-sheet with grinding tools.

We can best visualize the grinding and rasping effect of moving ice by comparing it with a gigantic file, the boulders forming the teeth. Thus the rocky bed is scored and scratched and the arrangement of the scratches serves as a guide to the direction of flow: many of the boulders tightly set in the ice become ground to powder and broken into coarser and finer pebbles. Some of them are eventually released as the end of the ice melts and lie embedded in the finer scourings deposited by the glacial streams. It is these boulder clays and beds of sand, gravel and silt which furnish some of the most impressive and easily recognizable proofs of ice-action on a large scale over regions that have long ceased to be Arctic.

Scattered over the greater part of the British Isles, the north German plain and many thousand square miles in Canada and the United States trails of boulders, rounded hills and hummocks, polished and striated platforms of rock, heaps of moraine—the accumulation of angular rocks from the waste of the valley sides on the surface of the slowly moving glaciers—with masses of boulder clay and innumerable far-travelled rocks, some many tons in weight, enable us to reconstruct scenes in regions that are now temperate when they were in the grip of an Ice Age. By careful microscopical comparison of boulders in America and Europe with the rocks of highlands and lowlands often far away, it has been possible to follow the leisurely journeys of the ice-sheets and glaciers during the long years of the Arctic age. In North America ice-sheets extended as far south as New York City and Cincinnati, while on the Pacific border of the continent the southern limit of the ice was rather farther north. In the British Isles a line drawn from the mouth of the Thames to Bristol marks approximately the southern edge of the ice-covered land.

A brief description of Greenland, more than three-quarters of which is still covered by a shield-shaped mantle of ice, will serve as the basis of a reconstruction of North America and Europe in the middle of the glacial period. During the short summer months nearly the whole of the western border of Greenland, a smaller proportion of the east coast, and a comparatively broad strip on the extreme north are relatively bare of ice and form a fringe, interrupted here and there by cliffs and jagged masses of tumbled ice where the snow-fields of the interior have pushed huge glacial tentacles through the deep troughs of fiords to the edge of the sea. Beyond the coastal fringe the interior of the country is a vast "storm-lashed desert of ice," but occasionally a dark mountain peak rises above the encompassing whiteness. These islands of rock, known by an Eskimo name, *nunataks*, escaped glaciation and remained as lonely sentinels above the buried foundation-stones of the continent. There is conclusive evidence in North America and Europe that the ice failed to reach some of the higher mountain tops, and as in Greenland to-day there were nunataks and unglaciated patches.

Lessons from Greenland.

This brings us to another problem which appeals to the botanist, namely, the effect upon the vegetation of the enormous extension of polar conditions into the temperate zone. Let us first see what can be learnt from Greenland. The flora includes nearly four hundred different kinds of flowering plants, a few ferns and allied plants, with a luxuriant flora of lichens

and other lower forms. That is to say, a country where there is still an age of ice supports a flora richer than the exceptional circumstances would lead one to expect. Save in the extreme south, where birches and alders attain a height of fifteen feet or more, the vegetation is treeless. Cape Farewell, the southern point of Greenland, lies slightly south of latitude 60° N.; the coast bordering the polar sea 1,700 miles away is the most northerly land in the world.

The only part of the country known to the writer is the region about half-way up the western side, including a portion of the mainland with the neighbouring islands—Disko, Upernivik, Hare Island, and others. There in the almost incredibly short summer, especially in the far north, when the daylight is summer-long, the ice-free margin is in places bright with flowers: hillsides are carpeted with a tangle of low shrubs and herbs; on the more barren and stony ground grow cushions of Arctic and Alpine plants, prostrate willows and the dwarf birch, with a wealth of lichens ranging in colour from deep vermilion to yellow and white. It is not only the relatively warm coastal belt which supports flowers and stunted shrubs; several flowering plants are recorded from nunataks separated by several miles of ice from the edge of the inland sheet. Nearly thirty flowering plants were found on a nunatak at about latitude 62° N. in west Greenland 414 miles from the margin of the ice-field at an altitude of 5,600 feet. An even more surprising fact is the occurrence of eight flowering plants on a nunatak at 81° N. latitude.

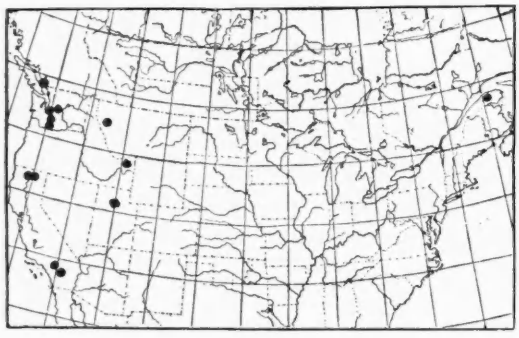


FIG. 1.

Map of part of North America, showing the geographical distribution of the fern *Polystichum mohrioides* var. *scopulinum*. (From Fernald.) The black dot on the extreme right is on the Gaspé peninsula.

A comparison of the present flora of Greenland with the floras of other Arctic lands in North America, Europe and Siberia shows that many of the plants are members of a far-flung circumpolar flora, widespread representatives of a community characteristic of the islands and continental areas girdling the polar sea. But associated with these Arctic plants in Greenland are several species that are common in temperate floras. It may be objected that while Greenland, ice-bound though it is, can now support a comparatively rich flora, it must have been barren when the Ice Age was at its maximum. The piles of glacial refuse which one sees on the western border of the country several miles from the nearest glaciers show that the extent of the ice was formerly greater, and that possible refuges where plants could revive after the long Arctic night and rapidly complete their life-cycles in the short summer were undoubtedly fewer.

We have no means of giving an authoritative answer to the question: was Greenland at the height of the glacial period totally deprived of vegetation? On this point many different opinions have been expressed; it must suffice to state the view of the late Professor Ostenfeld of Copenhagen. He thinks that about 60 species out of the 390 probably lived through the great ordeal, while most of the remaining 330 entered the country by natural agencies, some driven by wind across the frozen sea, some carried by birds and other animals; and he suggests that 13 per cent may have been introduced by the Norse colonists in the tenth century when Eric the Red persuaded a band of his fellow countrymen to desert Iceland for the land that was said to be Green, taking with them sheep, oxen and fodder. If nearly four hundred flowering plants are able to exist in Greenland there would seem to be no great difficulty in believing that other, more southern lands could experience an ice age without losing the whole of the vegetation.

Before the Ice Age began it may be assumed that an Arctic vegetation encircled the polar ocean; as the climate of the northern hemisphere became colder the circumpolar plants gradually increased the area of their distribution and followed the advancing ice into sub-Arctic and eventually into temperate regions. The Ice Age was not a stage in geological history when climatic conditions remained uniform; there were advances and retreats of the ice-sheets and glaciers, periods of intense cold alternating with comparatively genial interludes. The first serious invasion of the North American continent was along the western Cordilleras, the Rocky Mountains, the Cascade Mountains and the Sierra Nevada: this was the Cordilleran ice-sheet which reached nearly to latitude 45° N.

At a later stage a vast ice-field to the north-west of Hudson Bay was the gathering ground of another

set of glaciers, the middle, or Keewatin ice-sheet, which spread for a distance of 2,000 miles from north to south and 1,300 miles from west to east. Still later this was followed by the gradual development of the Labrador ice-sheet which reached the eastern coast. The successive advance of these sheets caused almost wholesale devastation of the vegetation which lay in their path, though some of the plants were able to reach safety many miles to the south. Some few of the hardier plants may have held on to life in sheltered crannies or on the higher slopes of mountains which remained as nunataks in the frozen desert. Beyond the southern edge of the ice-sheets such species as were efficient travellers spread from place to place as their former homes were ruthlessly laid waste and established themselves over the plains and on the lower slopes of hills. Later, as the climate improved, some of the plants were able to return towards their former home; others remained in the lands which had given them shelter, deserting the plains as the climate became inconveniently warm for colder and more congenial quarters on the higher slopes of mountains. Hence it is that many Arctic species are familiar elements in Alpine floras in districts remote from their native country. They are outliers of an Arctic flora, legacies from a former age.

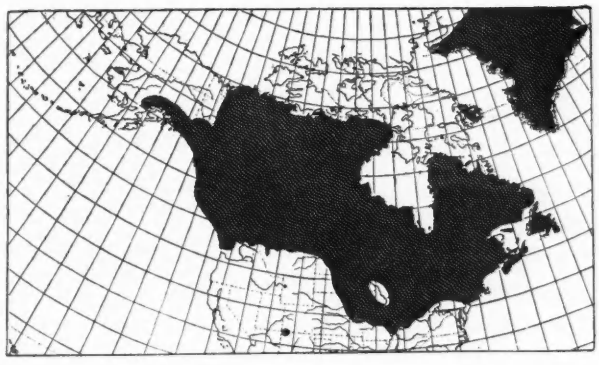


FIG. 2.

The maximum extent of the Quaternary (Pleistocene) ice shown in the black areas in Greenland and North America. (From Fernald.) The unshaded areas in the map remained comparatively ice-free.

We now turn to another line of enquiry which has thrown a welcome light on the possibility of the persistence of plants in a glaciated country. Geologists assure us that a wide area in the American Arctic Archipelago was never completely covered by ice even when the conditions were most severe. Similarly some parts of the Gaspé peninsula and other districts bordering the Gulf of St. Lawrence (which for convenience of reference will be spoken of as Eastern Laurentia) are known to have escaped glaciation.

Here comes in the botanist; Professor Fernald of Harvard University has shown that in Eastern Laurentia there are several hundred different kinds of plants which are not identical with the widely distributed circumpolar species, but are, he believes, members of an older race which lived through the glacial period in the more northerly parts of the almost completely ice-covered territory. A critical examination of this Eastern Laurentian flora has revealed the fact that many of the plants are peculiar to the districts where they occur; they are species known to botanists as endemics. There are at least, Professor Fernald says, a hundred endemics. This feature of the flora is in marked contrast to the almost complete lack of endemic species in Greenland, where there are not more than four in the whole island.

The occurrence of a large number of peculiar species is believed to be evidence of unmolested occupation of an area and of long continental operation of the factors governing evolution. On the other hand, in regions where endemic forms are rare the conclusion seems reasonable that the plant population has been more disturbed by migration, by wanderings to and fro; in the unsettled circumstances due to the ousting of the plants from their homes by advancing ice-sheets, little or no progress was made in the manufacture of endemic species. A most interesting and significant feature of the Laurentian flora is the identity of many of the plants with species in California and in other districts in western America, two thousand miles distant from the mouth of the St. Lawrence, while in the broad intervening area they are unknown.

Two chosen from many examples will serve as illustrations: the first is a fern allied to the holly and Christmas ferns, a variety known as *Polystichum mohrioides* var. *scopulinum*; the species, *Polystichum mohrioides*, of which the fern in question is a variety, has an unusually wide geographical range and occurs not only in North America but reaches as far south as the Falkland Islands and Tierra del Fuego; it is also found at remote stations on the Andes. The Gaspé variety, on the other hand, has a much more restricted range—its most westerly station is in South California; passing eastward it is next recorded at a locality five hundred miles away; it occurs also three hundred miles to the north and after a wide gap reappears in Eastern Laurentia (Fig. 1).

The second and equally striking example of the discontinuous geographical range of the Gaspé plants is a species of willow with white, silky foliage, *Salix brachycarpa*; this occurs in British Columbia, Washington and Oregon, and, after a gap of fifteen hundred miles, on the Gaspé peninsula. This Laurentian plant-community, of which two examples have been mentioned, is an isolated group, an outlier of a flora distinct from the older and more familiar circumpolar flora with its greater continuity of geographical distribution; the eastern flora, Professor Fernald believes, occupied the territory bordering the Gulf of St. Lawrence before and during the last phase of the glacial epoch. Unlike the circumpolar flora, it was not driven out of its home by the Labrador ice-sheet; it is a relict flora which successfully maintained a precarious existence on rocky ridges and other ice-free stations when the surrounding land was covered by a mantle of ice.

The evidence in favour of this conclusion may be briefly stated: the number of peculiar, or endemic species, is very large; this in itself, as already explained, suggests antiquity. But why should there be a gap of fifteen hundred to two thousand miles between this ancient Laurentian community and its representatives in the far west and in the Arctic Archipelago? It is noteworthy that several of the Gaspé plants extend far to the north in the north-west portion of the Arctic Archipelago where they occupy regions never completely denuded by ice.

Before the glacial period began a vegetation flourished in the Arctic Archipelago, which included a large number of plants now growing in Eastern Laurentia, Arctic Siberia, and on the western Cordillera. As the first great ice-sheet swept from the north over the Pacific border of the continent, members of this old Arctic flora were able to spread farther south; some of them wandered eastward from the Cordilleran range and established themselves in places not yet reached by the second or Keewatin ice-sheet. Gradually the Keewatin ice encroached upon the new home of the travellers, and those which had not reached a safer haven beyond the eastern margin of the oncoming ice were destroyed.

Wanderers which Reached Safety.

But the plants which had gained a footing on the Laurentian hills dug themselves in on the higher slopes of the Gaspé mountains and on other parts of the St. Lawrence area which we know were never completely overwhelmed by the destroying ice-sheet. There they remained: a company which had fled from the west in face of the threatening danger of extinction as the ice-fields gathered in strength, until eventually they reached the Laurentian terminus and occupied a territory which included areas never completely covered by ice.

These areas, still tenanted by members of the ancient pre-glacial flora, may be compared with rents and holes in the ample folds of a gigantic mantle. But, it may be asked, why, on the return of more genial conditions as the ice finally withdrew, did not the plants increase the borders of their territory and re-occupy the ground that lay open to invasion? This failure to spread is attributed to the loss of youthful vigour; the eastern plants were "so old as to be almost extinct."

Survivors of the Ice Age.

The story of this once vigorous flora has been told only in part*; the facts to which special attention is directed afford a convincing argument against the popular belief that the Ice Age completely destroyed the vegetation of the invaded regions. Great as the destruction of plant-life must have been both in North America and Europe it was not as wholesale as used to be supposed. While there can be no doubt that by far the greater part of the vegetation was destroyed or driven temporarily to the south, some persisted within the glaciated area. The best evidence of the devastating effect of the ice is afforded by the European flora, particularly in the region north of the Alps.

In the halcyon days before the Ice Age many trees and shrubs were abundant in northern Europe, reaching well beyond the Arctic circle, which are now confined in the northern hemisphere to America and the Far East. As the glaciers and ice-sheets advanced over Europe, magnolias, the tulip tree (*Liriodendron*), *Sequoia* which persists as a giant of remote antiquity on the border of the Pacific coast, and a host of other plants that are no longer European, were forced by the general lowering of temperature to seek more southern and warmer quarters. But a limit was set to their wanderings; the way to safety was blocked by the Alpine barrier and the Mediterranean Sea. In America there were no such barriers and in the Far East the migrating plants were able to reach their present resting-places through the highland valleys of Tibet and China. Thus it is that the vegetation of north and central Europe is now much inferior to that to the east and to the west.

*Fuller information is contained in a paper by Professor Fernald on "The Persistence of Plants in Unglaciated Areas of Boreal America," published as one of the Memoirs of the Gray Herbarium of Harvard University in 1925.

Egg Shells Sixty Million Years Old.

By Glenn L. Jepsen:

Department of Geology, University of Princeton.

We follow the article in last month's issue on the excavation of dinosaur beds in Africa with an account of the recent discovery of dinosaur's egg shells in Montana. This is the first official account to be published in this country and the author corrects the inaccurate reports which have appeared elsewhere.

SECURELY tucked away in the rocks of the Bighorn basin of Wyoming and Montana is the " diary " of a huge fossil reptile group. Whole chapters of the chronicle are missing, but the preserved volumes tell of the long and wealthy life of the dinosaurs and their mysterious racial death. Among the upper Cretaceous, footprints, egg shell fragments, bones and teeth of the dinosaurs and their animal associates, and plant remains serve as records.

The Dinosaur's Nest.

To know how the fossil monuments are deciphered one must first visualize the Bighorn basin as it appears at the present time. It is a vast sediment-filled hollow, surrounded by a gigantic horseshoe rim of high, often snow-capped mountains, narrowly open to the north. Geographic convenience divides the mountains that fashion this arcuate welt of the Middle Rocky mountain-front into several ranges. The Absarokas, near Yellowstone Park, are its western side, while their southern extremity winds eastwards and merges with the Owl Creek and Bridger ranges which form the back arch of the horseshoe, opposite the northern end. On the east, the lofty Bighorn Mountains sweep north from the Bridger range and extend into Montana as the Pryors which decline into the plains.

Flowing northward, the Bighorn River enters the depression through a southern " notch " between the Owl Creek and Bridger mountains ; it courses across the basin for about a hundred miles, collecting tributary veins as it goes, cuts through the eastern rim of mountains and meanders across the Montana plains to discharge into the Yellowstone River. Much of the basin's surface is nearly a mile above sea level, and some peaks on the eastern mountain rim tower even a mile and a half higher. Geologically, the formations of the basin are like a gigantic set of nested dishes with the rims of lower vessels exposed round the outer margins, lapping upon the mountains. As the observer approaches the middle of the basin he crosses the edges of successively younger and softer strata.

" Mauvaises terres à traverser," the early French traders must have exclaimed when they tried to cross the dry, hot, rugged country which they found in parts of the area. The name " Badlands " has stuck to the type of desert topography which develops when soft rocks are eroded by blasting winds and infrequent but torrential rains. The Badlands in parts of the Bighorn basin look from an airplane like great masses of carelessly crumpled paper, tan, red, purple and grey, partly unfolded and smoothed. These areas of jagged waste, parching and secretive, rebuff the traveller and beckon to the vertebrate paleontologist, for here he uncovers the hieroglyphs which compose his " Book of the Dead." It is a colourful, mighty sarcophagus, its distant blue edges daubed with white.

Sagebrush, yuccas and cactus characterize the local flora, and the animals which the collector most commonly encounters are jack rabbits and hares, shy antelope, coyotes, little prairie dogs, owls, rattlesnakes and furtive lizards. Often the drinking water in such sparsely inhabited regions must be hauled for many miles in wooden casks or metal cans. The industrious and hospitable Mormons have carried out huge irrigation projects. The fertile belts are fringed by forlorn epitaphs of farms, begun by ambitious men who tried to outwit the climate and lost bitterly.

Birth of the Rockies.

To trace briefly the history of the country and to understand the fossil landscape upon which we can project our knowledge of the dinosaur, we must begin millions of decades ago, before the Upper Cretaceous rocks were deposited. The whole region rested uneasily, five or six thousand feet below its present elevation. Marine water, perhaps an arm of the Pacific Ocean, covered most of the area. Ancestors of the present great mountains appeared as low island arcs. Slowly, the crust of the earth rose, wavering up and down, with more and more land appearing above the water, until at last the sea was only a memory, retained as a fossil record. The mountain ranges grew upward a little faster than the rest of the

rising earth block. Thus, in short, the ancient Rockies around the Bighorn basin came into being. The highland rocks broke up and supplied sand and clay which the wind and rivers carried to the broad lowlands; volcanoes contributed ashes. The climate was warm and moist, and great "fern trees" and other plants decked the country.

Many kinds of dinosaurs flourished. Their size and shape varied from slim little creatures to bulky giants almost a hundred feet long. Many ate only plants while others preyed upon living animals for food. They lived on the land and in the sluggish rivers and warm lakes. Some laid eggs and some bore living young. Among their acquaintances numbered little warm-blooded creatures that we should call dull-witted; but in comparison with the dinosaur the early mammals were extremely resourceful. Birds sang in the trees, crocodiles grunted among the lilies in the swamps and turtles basked on the banks of the streams. In the water lived gars and other fish and many kinds of clams and snails. This and much more is read from the Cretaceous rocks concerning the dinosaur.

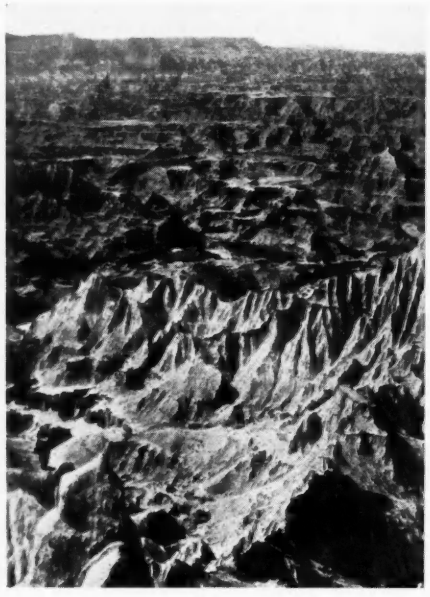


FIG. 1.

"BADLANDS."

From the air the Bighorn basin resembles a mass of crumpled paper, and has been given the appropriate name of "Badlands."

Mysteriously the whole group died. Above a certain level in the rock layers not one single note remains about the dinosaurs. The greatly condensed lithic history makes the extinction look very rapid. In one stratum we find dinosaur bones and footprints; twenty feet higher there is not a trace. In terms of years the time may actually have been long. What happened? We do not know. Many suggestions have been made. Perhaps the climate changed and made for the unwieldly dinosaurs a strange and unfriendly world. Was there a widespread epidemic of bacterial infection? Did hordes of parasitic insects attack? Were the competitors for the same life-realm too numerous and clever? All we have is the fact, with little or no attending explanation, that the dinosaurs disappeared at the close of Cretaceous time.

For the bone-hunter there are no more exciting rocks to browse among than those dating from just before and immediately after the demise of the dinosaur. It is a critical time in earth history. Mammals gained in nature a throne from which they have since dictated. Where did the new types come from? Again our ignorance is abysmal. We hoped to learn from recent research that Mongolia was the incubator of the early mammals, but the discoveries there are of unique fossil forms only distantly related with America's early Tertiary inhabitants.

Who were the dinosaurs? Their name is used almost as loosely as the term "quadruped." Dinosaurs cannot be defined except by long anatomical descriptions. In short they were a great group of related reptiles whose diverse characters the systematists have placed in two orders and six sub-orders. For excellent discoveries of dinosaurs in various parts of the world, and for successful elucidation of remains and habits of the fossil reptiles, many British naturalists deserve praise.

Dinosaur tracks were described as "Noah's raven's footprints" at the beginning of the last century. Of scant scientific importance, they nevertheless assume an exaggerated value in the public eye. Perhaps their greatest use was in saving an old American college from dissolution: a testy controlling board refused to vote the institution enough money to exist, but allowed funds for the excavation of a collection of dinosaur tracks. Stealthily, part of the appropriation was diverted to feed a scanty but staunch faculty group. To-day the college has large rooms full of superbly preserved tracks on rocks of early Mesozoic age. Petrified eggs, presumably of dinosaurs, rewarded the American Museum collectors led by Roy Chapman Andrews in Mongolia several years ago. Since the initial discovery, dozens of whole egg shells and hundreds of fragments have been collected in the Gobi Cretaceous. These stimulated an attempt to answer the question, how can one tell from the shell whether the egg was laid by a turtle, a bird, a crocodilian or a dinosaur?

It is sufficient to say here that differences of structure can be observed when specimens are carefully examined under powerful microscopes. The variations reflect slight differences in formation of the shells within the parent reptile and bird bodies where, when first formed, the soft eggs are covered with a membrane. Specks of lime material appear at many points in the membrane and then accrete more lime round them until the resulting spheroids have grown together; a complete calcareous case is thus formed round the egg, with minute pores between the coalesced spheroids. This is the "mamillar" zone. The inside curves of the small bulbs can be seen in Fig. 2, C and D. Round the exterior of the mamillar zone successive layers of the same material thicken the shell. The outer zone, above the spheroids, is described by the name "prismatic." All dinosaur egg shells that have been found show common differences from other shells. The significance of these variations is still being studied.

A party from Princeton University spent last summer gathering information from the Upper Cretaceous of Montana. Mr. Maurice Black of Cambridge University accompanied the collectors to take a last look at Western American geology before returning to England. He departed a short while before the accidental discovery of fragments of dinosaur egg shells hitherto unknown in America. Following the announcement of the find, the Press published some amazing accounts. One editor related how years of search had revealed a whole nest of complete eggs! An English professor, having produced a publication comparing egg size with incubation period, wrote, "It was with some amazement that I learnt from the Press that your dinosaur eggs were eight feet long." His amazement was only exceeded by our own. Fig. 2 compares some fragments of Mongolian with Montana dinosaur eggs. In many respects they are almost identical. An expert who examined the eggs pronounced them all of the same kind.

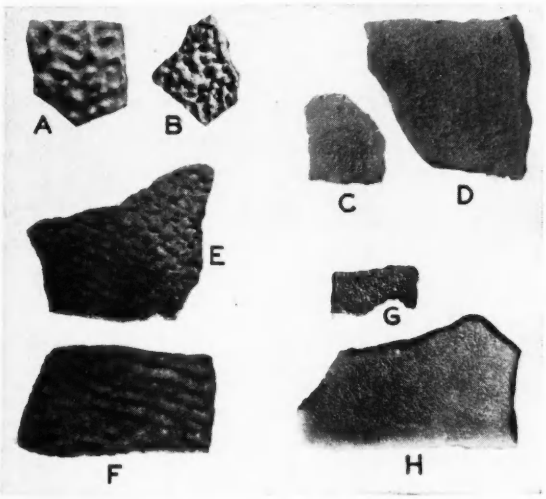


FIG. 2.

FRAGMENTS FROM MONTANA AND MONGOLIA.

These photographs show the similarity between Montana and Mongolian egg shells. A, D, F and H are Mongolian, while B, C, E and G are from Montana.

FIG. 3.

SEARCHING FOR EGG SHELLS.

The difficulties involved in the search for egg shell fragments can be seen from this photograph of investigations among the rugged wastes of the Bighorn basin.

That the Montana fragments were at one time parts of the case which enclosed a potential or actual dinosaur embryo is considered probable, although as yet no whole eggs have been reported from America. The evidence is microscopic structure, external appearance and size as judged from the curvature of the preserved pieces. From the latter evidence, the whole eggs must have been larger than the Gobi eggs, which vary from about three to seven inches in length. The Montana shell, deep brown and black in colour, is about one mm. thick. Hillocks and valleys modify the external surface. Magnified cross sections show aeriferous canals piercing the thin mamillar zone and the relatively thick prismatic layer, similar to corresponding views of the Mongolian eggs. These pores permitted an exchange of gases between the developing embryo and the air. Almost pure calcite composes all of the shells.

Further search in Western United States may reveal additional material that will permit a more complete comparison with the Asiatic specimens, as well as with some eggs from Rognac, supposedly of the dinosaurian *Hypselosaurus priscus*, and fortify or change the present conclusion about the derivation of the Montana fragments.

South America: (4) Across the Andes.

By John A. Benn.

Continuing his South American diary, the Editor describes a journey across the Andes from Chile into Argentina. In the July issue of DISCOVERY, *Mr. Benn will describe a visit to an "estancia" in the north of the country, and the series will conclude with some impressions of Brazil.*

THOSE who have travelled on mountain railways in Switzerland will probably be disappointed by the journey across the Andes. The thought of the train climbing over 10,000 feet suggests magnificent views, extending for perhaps fifty miles across the plains below. Actually the railway winds along a series of valleys shadowed on all sides by mountains. There are magnificent peaks but very little sense of distance and space. For sheer pleasure in scenery, a first visit to the English Lake district was, in my experience, more memorable than crossing the Andes. I am told that a better impression is obtained by going from east to west, instead of starting as I did from Chile.

Varied Scenery.

The journey was extremely interesting. The mountain railway on this side begins at Los Andes, but to cross the continent one must start at Valparaiso or Santiago, whence the train to Buenos Aires runs twice a week. This first section shows the varied character of the country. From the coast, the line passes through fertile valleys with every sort of vegetation to a barren region where only dwarf bushes and cactus plants can grow. Then this hilly region gives way again to the rich country round Santiago, 2,000 feet above sea-level.

These contrasts seem less marked after seeing the coastal scenery of Chile. It is impossible to believe that the north and south are in the same country. For nearly a week before reaching Valparaiso the steamer sails past barren hills where rain is so rare that houses can be safely built of mud instead of bricks. The ports are like oases, where a few trees are kept alive by constant watering, but the sense of desolation is heightened by the cemeteries which are usually seen in the desert a mile or so outside these towns. This part of Chile contains the nitrate fields described in *Discovery* last month. The monotony is broken in a few places, such as Tacna, where there is a small green valley in the midst of the wilderness.

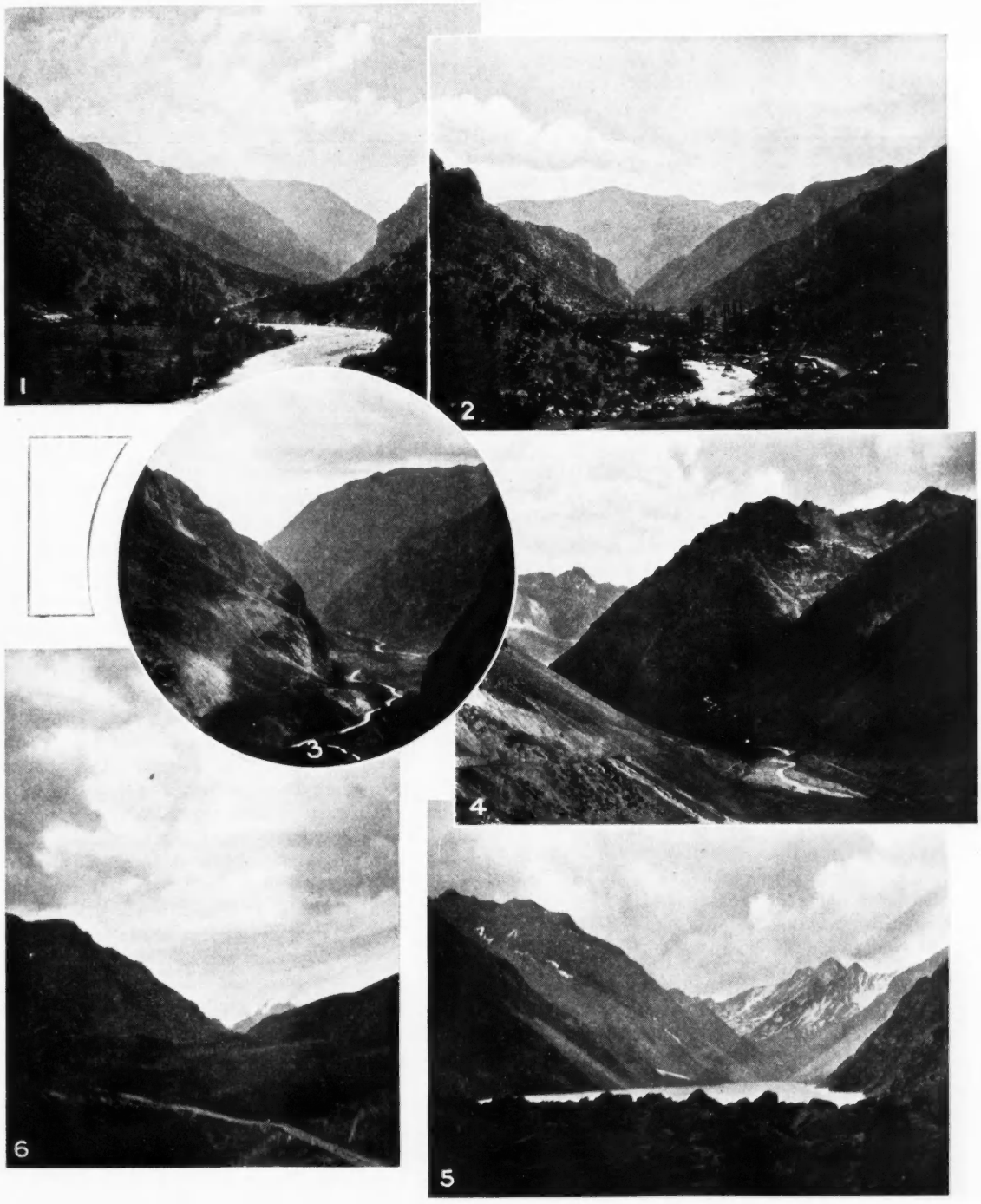
Approaching Valparaiso the climate becomes temperate again and trees begin to appear. The city is built on the hills that surround the bay, and has many beautiful gardens. Most of the buildings are modern, erected after the terrible earthquake of 1906, but the streets afford a curious mixture of the old and the new. Horses and mules are still used as beasts of burden, and it is amusing to see a policeman holding up a tram to allow a peasant to ride by with his load of firewood or melons. Some of the roads in the city are too steep for cars, and I saw one horse carrying a sideboard, complete with drawers and mirror. In places there are cliffs of rock, which are provided with lifts to take the public from the lower to the higher level streets.

The journey from Valparaiso to Los Andes takes four hours, and here the mountain railway begins. At first the line follows the River Aconcagua through a richly cultivated valley. This part of Chile enjoys plenty of rain, as the clouds from the Pacific are stopped by the mountains, but on the Argentine border there is practically no rain at all. The natural fertility of the Chilean foothills is in sharp contrast with these dry slopes, but a remarkable system of irrigation has turned the country round Mendoza into a prosperous area renowned for its vineyards.

The train climbs gradually at first and gives frequent glimpses of the motor road which follows the river on the opposite bank. At Rio Blanco the river becomes a white foaming torrent, and the same name ("White River") has been given to a station on the Argentine side, where the Mendoza River shows similar characteristics. Trees and rich grass form a picturesque foreground to the rugged peaks above, which are bare except for patches of mossy verdure. After Rio Blanco the line becomes steeper and chasms appear below as the train labours up the mountainside.

The Upward Climb.

The best impression of the great height to which the train climbs on this part of the journey is obtained between Guardia Vieja and El Juncal. Soon after leaving the first of these stations one sees the line high up on the other side of the river, and ten minutes later the view is reversed—the lower line appearing



ACROSS THE ANDES.

1.—A view between Los Andes and San Pablo. 2.—Leaving Rio Blanco, Chile. 3.—Aconcagua Valley near Guardia Vieja. 4.—The railway line between Guardia Vieja and El Juncal. 5.—The Inca Lake near Caracoles. 6.—Looking towards Aconcagua. (These photographs were taken by the author from the train.)

like a footpath in the valley below. On these slopes the railway is protected by wooden sheds built at intervals over the line to prevent damage from avalanches.

The final climb to the tunnel now begins. The steepest section of the line is between El Juncal and Caracoles, the train rising 3,000 feet in less than one hour. The rock scenery here is remarkable, and every turn and twist of the railway brings another group of peaks into view. Some writers describe this scenery as the most magnificent of its kind in the world : it is undoubtedly magnificent, but lacks the long-distance views which can alone give a true sense of great height. Except for the sudden cold here, it is difficult to realize that one is travelling on one of the highest railways in the world. The cold is especially noticeable after the summer heat of Valparaiso, left behind a few hours earlier, and it is strange to see the railwaymen wearing thick cloaks. Near the station at Caracoles, The Inca Lake suddenly comes into view and shows up the snow-capped peaks to greater advantage.

The summit tunnel through the Cumbre mountain is 10,420 feet above sea-level and about two miles long. It was cut through the rock 3,000 feet below the summit. In 1903 the Argentine Great Western Railway took over the working of the Transandine Railway, which at that time was only constructed as far as Las Cuevas. Four years later this working agreement was transferred to the Pacific Railway, but it was not until the autumn of 1910 that the tunnel was terminated and railway connexion completed between Argentina and Chile. Before the tunnel was opened the pass had to be crossed on mule-back, and while sitting in a comfortable train I recalled that my grandfather was one of the last to make the mule journey, during a visit to Argentina for the centenary of the Republic earlier that year. The railway traveller does not see the statue of Christ on the boundary line between Chile and Argentina, but it may be reached by the old road higher up the pass.

A Glimpse of the Highest Peak.

The blue and white flag at the frontier post indicates that we are now on the other slope of the Andes, and the train quickly descends into Argentine territory. Soon the clouds which cover the summit give way to sunshine again, and in the distance we get a glimpse of Aconcagua (22,850 feet), the highest peak in South America. The different geological character of the mountains on this side is at once obvious, red sandstone taking the place of crystalline rock. In the afternoon sun the contrast was very marked, the mountains appearing a brilliant pink instead of dull grey.

A descent of 2,000 feet brings the train to Puente del Inca, so-called because of the natural rock bridge which spans the Cuevas river at this point. The bridge is 60 feet long and the same distance above the water. The railway passes close to this curious formation and soon brings another freak of Nature into sight—a great mass of rocks shaped like a cathedral. The resemblance is made more striking by some smaller rocks near one end, which look like a group of monks walking into the cathedral, and have given it the name " Los Penitentes." On a clear day a view is obtained of Tupungato, a majestic peak forty miles from this station.

The Old Indian Trail.

The line slowly descends the valley of the Mendoza. The river has cut such a deep course through the sandstone that for some miles the sides are as regular as an artificial embankment. There is no vegetation to retard the process of denudation or to cover up its results. The train here follows the old Indian trail to which the Spaniards gave the name " Camino de los Andes." It is now getting dark in the valley but the sun still shines on the mountain tops, giving them a warm red glow. Mendoza is reached at 10 p.m. and the traveller changes into an express train for the journey of seven hundred miles to Buenos Aires.

After the mountain scenery, it seems strange next morning to be travelling at sixty miles per hour across the plains. As far as the eye can see on both sides the country is flat—so flat that the occasional *estancia* houses look like ships on the horizon. This part of Argentina is admirably described in a new book* by Mr. F. A. Kirkpatrick, who remarks that a man may ride day after day and always alight on a spot hardly to be distinguished from his starting point. The Pampa was once the bed of an inland sea and is covered with a layer of rich soil on which wheat and other crops flourish. The land is less fertile in the west where wells and irrigation are employed, the biggest reservoir being in the Cordoba hills.

In crossing the immense plain that stretches from Mendoza to the sea, the traveller sees a rapid cross-section of Argentina—the vast wheat growing areas of the west, then the rich country where some of the finest cattle in the world are raised. The city of Buenos Aires is cosmopolitan and does not represent the real life of the country, which has depended for centuries on the plains. I shall describe a typical *estancia* in my next article.

* " A History of the Argentine Republic." 1931. (Cambridge University Press.)

Handicrafts of Cyprus.

By James Hornell, F.L.S.

Many of the handicrafts of Cyprus are reminiscent of the Middle Ages in this country. But the Cypriote craftsman possesses real ability and with up-to-date technical instruction would be capable of fine work.

In Cyprus, as in all eastern countries, indigenous handicrafts are carried on in full view of the passers-by. There are no trade secrets, or, if there are, little trouble is taken to hide them. The workshops of these trades may have a narrow frontage to the street, always open, but within they are generally loffy rooms, extending far back, dimly lit, cool and obscure. Where the European would use a partition wall or pillars to support the roof or ceiling, the Cypriote builder prefers the arch; he still retains some of the constructive skill and methods of his Byzantine preceptors.

Some of the handicrafts to be seen in the maze-like bazaar of Nicosia, or in the little villages scattered along the lower foot-hills of the two mountain ranges enclosing the central plain, are of peculiar interest to the stranger from the West. They carry him back centuries in the life of England and, like the feudal customs in parts of India, help to give him a clearer conception of the life of that dull and circumscribed age so often miscalled "the good old days."

The manufacture of thick felt for the lining of saddles is still of some importance. At the far end of the single-roomed shops where the industry is plied a man or boy may be seen engaged in cleaning the rough wool, matted and full of dirt. He uses a queer instrument that might be mistaken, if seen apart, for an outlandish one-stringed musical instrument, a twanging wire stretched between the ends of a bow-shaped frame. When in use the instrument, held by the bow in the left hand, is turned wire downwards and touching the mass of wool to be cleaned; with his right hand the worker strikes the wire sharply with a wooden mallet, and at each blow and resultant vibration of the wire some of the matted wool breaks up, fluffed out and freed from some portion of the adherent dirt. So he goes on monotonously, rhythmically beating the wool until a soft, fluffy mass, white and clean, represents the results of his labour.

AN ITINERANT WOOL CLEANER.

An odd device resembling a grotesque musical instrument is employed in cleaning the rough wool used for the lining of riding saddles.

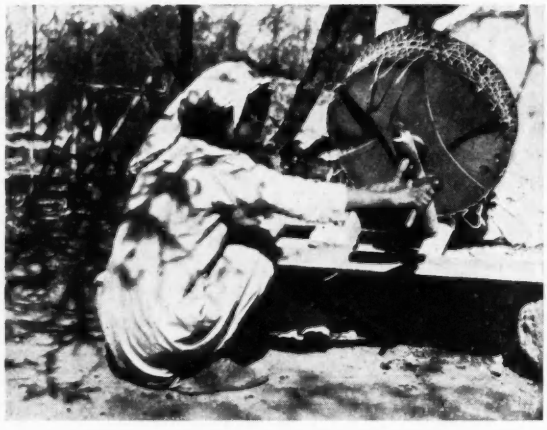
Meanwhile a piece of coarse matting made from the leaflets of the date palm has been spread on the floor, some twelve feet in length. A second man picks up an armful of the prepared wool and, with the help of a long-pronged hand fork or comb, flicks it in light downy masses over the matting as evenly as possible. So he continues until enough has been spread. The fluffy layer, rising about five inches above the matting, is now ready to be compressed into felt, but first it must be sprinkled lightly with water and, perhaps, marked with some symbol in red or blue to make it more acceptable to Moslem or Christian. To do this small wisps of coloured wool are laid at the centre of the mass, arranged to show as a crescent or a cross when the process of felting is complete.

The layer of wool and its underlying matting are next rolled round a thick cylinder consisting of an axis of wood enveloped in several layers of old felting, they are made secure by several lashings of cord. For the next half hour two men and a boy slowly roll this bulky cylinder backwards and forwards the full length of the workshop, each with a foot on the roll, exercising pressure continuously. When they cease rolling it, the lashings are untied and the mat unrolled. The now consolidated woollen layer is examined for flaws, for weak

spots either too thin or too lumpy; these remedied, the felted wool is re-rolled on the cylinder and trundled to and fro on the floor for a second time. After about a quarter of an hour the strip of felt is ready to hang out to drip and dry upon a line stretched along the shop front.

Another primitive handicraft is that of the candle-maker, who in Cyprus continues to do a brisk trade in the manufacture of long dipped candles for presentation in the Christian churches as offerings from the faithful. The only concesson to the altered conditions of the present day is the employment of paraffin wax in place of tallow for white candles. Yellow candles are much in demand but are more expensive, and island beeswax is used. Two different processes are employed. The first, for very long candles, is identical with the old English method; a piece of doubled wick of the desired length is dipped repeatedly into a tall vessel filled with melted wax until a sufficient thickness has been obtained. Between dippings the looped upper end of the wick, which is not immersed into the wax, is threaded upon a thin bamboo which when full is carried outside the shop to cool. By the second method the candlemaker, after melting his wax, holds a length of wick pendent from one hand above a bucket of melted wax and with the other pours melted wax from a ladle along the strands of the wick. To give a purchase for suspension, the candles are made in pairs, a few inches of uncoated wick separating the two. The wax cools quickly; as each pair is coated the units are hung astride a line or a length of bamboo; when this will hold no more it is carried outside and rehung in order to cool thoroughly. As in the first method, additional coats are given until the thickness required is obtained.

In these candle shops wax votive offerings are also made; as they hang in jumbled disorder—small models of legs, feet, hands, babies' heads, and other parts of the human anatomy—they bring back gruesome recollections of the horrors of the quack medical museums once to be found in English towns and still to be met with at fairs in France.



A WEAVER AT HER WHEEL.

The weaver plies her craft in the open, in full view of the passer-by. The cloth is largely used in making the black breeches which are the orthodox wear of the men.

The Cypriote carpenters and cabinet makers are clever workmen; the island produces fine timbers which furnish excellent material for the production of handsome furniture. Carving in relief and in the round reaches a high degree of excellence, the main fault being its liability to damage because of the height of the relief. Ordinary carpentry is good but rough; the mass of the people are too poor to pay for anything that is not produced quickly and by semi-skilled labour. The patterns followed are usually of European-made articles of cheap and often vulgar design.

In the early spring much work is done for the farmers; the harvest occurs in April in Cyprus, so threshing appliances must be repaired or renewed not later than March. These are of antique design; in fact, no changes whatever have taken place for the past two thousand years. The main appliance, the threshing sledge, is identical with the Roman *tribulum* described by Virgil in the "Georgics." To form a sledge, a ponderous plank, turned up gently at the forward end, is hewn out of the solid, entailing a great waste of timber; the finest pine is required, free from knots and imperfections. The length is six and a half feet and the breadth two feet. In the lower surface the carpenter punches many slots arranged in about twenty rows, with twenty slots in each. Into each he drives a sharp-edged flint knife or cutter, about two inches in length. The flints are obtained from knappers who carry on a primitive handicraft dating back to the early Stone Age when the stone-hatchet provided for the wants of his family. In Cyprus the flint-chipping trade is carried on by men who obtain their material in the form of angular vein flint from the beds of certain river torrents and who travel the country from village to village, supplying the local carpenters with the flint knives required to arm the threshing sledges. These, by the way, are dragged by a yoke of oxen round and round the threshing floor over sheaves of corn, until all the grain is separated and the straw cut into chaff. Wooden five-pronged forks and

broad-bladed shovels are also made by the carpenters.

Allied with the carpenter is the turner. He, too, is a furniture maker but his customers are the poorest among the peasantry. He turns out chairs and cots, spinning wheels and such simple necessities of life. His lathe is that of the Far East, two parallel wooden beams lying on the floor, connected by movable transverse bars; these serve to hold the lathe arms in a fixed position when the bars are arrested by the insertion of wedges at the connecting points. From the inner side of each beam, at the end away from the turner, a steel pivot is inserted. Between the two pivots is adjusted a length cut from a pine branch, roughly trimmed by a boy apprentice. The string of a bow, twisted once round the object to be turned, gives the necessary rotation when the bow is sawn rapidly backwards and forwards.

Rough lacquer bands of red, yellow and green decorate this turnery and are put on by holding the end of a stick of coloured lac against the revolving wood. The frayed end of a stick, held against the lacquered band, serves to impart a polish by friction during subsequent rotation.

Other trades carried on in full view of the public are those of the dyer, weaver, brass worker, shoemaker, confectioner, potter and saddler. Their methods with one or two exceptions are less archaic than those described, or possibly our modern methods in these trades have not varied so greatly from our own ancestors' as those of others. The principal occupation of the dyer is to dye the yarn required for weaving the cloth used in making the black baggy breeches which are the orthodox nether wear of the menfolk, particularly the Turk. Black head-kerchiefs are much affected by the Christian section of the peasantry, the Turk preferring to wear a fez or some form of turban.

AN OPEN-AIR POTTERY STORE.

The potter's skill is considerable, and instruction in colour-glazing should enable Cyprus to regain pre-eminence as a supplier of pottery throughout the Levant.

As to the potter, his skill is considerable, and were he given instruction in the methods of glazing in colours, his ability, inherited from ancestors who have followed this calling for centuries, should enable Cyprus to regain pre-eminence as a supplier of pottery throughout the Levant. The wheel he uses is of a serviceable pattern, a great improvement on the primitive form used in India, where the workman has to squat on the ground at his work. The Cypriote wheel has two discs at the opposite ends of a long upright axis; the lower disc is of large diameter and serves by foot action to revolve the smaller working disc, fixed at table height; thus the potter is able to sit comfortably while engaged in fashioning his wares. Properly built permanent kilns are used and all that is required to render these potters able to compete with much of the imported ware, and to extend their activities to the making of drain pipes and improved tiles, is technical training in the use of moulds, glazes and colours.

The potters of Korno form a separate class; they specialize in the making of huge spherical pots, three to four feet in diameter. But instead of forming them on a wheel they build them up by hand, slowly bringing them into form by means of strips or rolls of clay laid on in spirals or rings. They are used throughout the island as water butts and grain stores.

Weaving on primitive looms is still a living industry and in every village a curious form of spinning wheel, quite different from that of Western Europe, is much in evidence. To get the yarn into convenient hanks for spinning, a curious device consisting of a long rod with a peg fitted in at right angles at each end, is employed.

A POTTER FILLING HIS KILN.

Properly built kilns are used by the potters, and all that is required to enable them to compete with imported wares is more up-to-date technical training.

Pioneer Memories of the Panama.

By Colonel A. C. MacDonald, D.S.O.

Following Mr. John A. Benn's article on the Panama Canal, the following letter and photographs have been received from Colonel MacDonald, who was himself associated with this famous engineering feat. He recalls the early difficulties of construction and the amazing enterprise and ability with which they were overcome.

I was much struck by Mr. John A. Benn's article on the Panama Canal in *Discovery* for April. In 1887 and 1888 the canal was a very different matter from what it is to-day. The original French design for a sea level canal from Panama to Colon had been practically abandoned owing to the failure of the financial side of the business, and the French were busy discussing various schemes for a lock canal from ocean to ocean. The plan adopted, if carried out, would have become obsolete before its final construction, as the draft of ocean-going vessels had increased so rapidly during those years that the canal would only have been operated by vessels of minor capacity. Thus its scope would have been so limited that its real object of conveying the commerce of the world would have been defeated at the beginning of operation.

The French had opened the work along the whole line of the canal from Panama to Colon; practically all the cuttings commenced by them were subsequently utilized by the Americans in carrying out their scheme of a lock canal with the Chagres River as the principal feeder for the Lake of Gatun. In those days we died of yellow fever, pernicious malaria and *calenturas* without being fully aware that the mosquito was the first actor on the scene. It is no exaggeration to say that the mosquito, combined with the rascality and stupidity of the French financiers, defeated the best efforts of the French engineers to whom great honour is due for their pluck, enterprise and ability in undertaking what has proven to be one of the vastest enterprises ever attacked by man. The difficulty of keeping together working gangs for more than a week was so great that many sections of the canal were half abandoned owing to the deaths among the staff.

The "beach" at Colon was an old coral reef on which the houses of the staff of the Panama Railway were built. This was the highest point on Manzanilla Island and was well exposed to the Trade Winds, which during eight months of the year kept the reef free from mosquitoes; it was possible to live there with considerable comfort. The rest of Manzanilla Island, on which Colon is situated, was only two feet above the level of the Caribbean Sea, and the back of the town was an impassable mangrove swamp, home of the land crab and alligator. When the Americans took over the Panama Canal, one of the first things they did was to raise the level of Manzanilla Island and fill the swamps, clearing them for a long distance at the back of the town and thus eliminating the mosquito in Colon and converting it into an habitable base camp. During the French régime, two "dead trains" were run each day from Colon to Monkey Hill, where the dead could be comfortably disposed with proper graves. Anybody dying in Bottle Alley, which was the thoroughfare at the back of Main Street, was generally put outside and picked up by sanitary authorities in the morning before the land crabs could get at him.

DRY EXCAVATOR AT WORK IN CULEBRA CUT, 1887.

The French, and later the American engineers experienced constant slides at Culebra Cut during construction and even after the canal was open to operation.

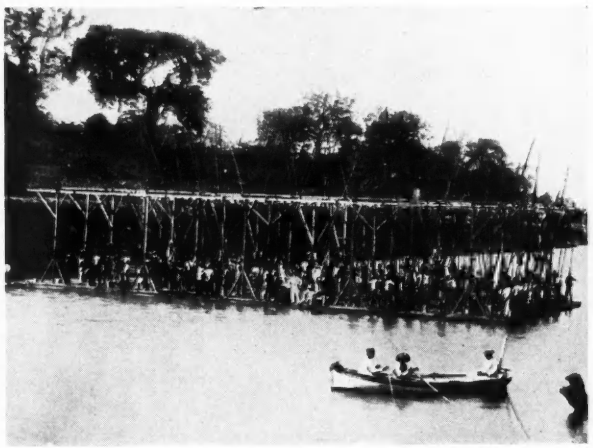
On the engineering side the French were well up-to-date. The mechanical equipment was, for its day, the

best that could be obtained. Some of the dredges of the American Contracting and Dredging Company, directed by Canadians with American capital, were capable of excavating up to five thousand cubic metres a day and discharging it on the sides of the Canal. These machines were ahead of their time and their performance has not been beaten by later types. Electricity was still "muling and puking in its nurse's arms," and although telephones were in use all over the Canal, they were far worse than the much abused system of to-day. Sanitation was in its infancy. The hospitals installed by the French were quite inefficient, whereas the American Railway hospital was excellently run and had a much lower death rate than those of the canal company.

Other than the climate, the greatest engineering difficulty was the control of the Chagres River. In this case the French engineers had not shown as keen an appreciation of the difficulties as they had in other respects. The attempt to force the Chagres through straight and narrow channels was disastrous and costly, and was finally abandoned after great expenditure when the original scheme of the sea-level canal was given up. The cut at Culebra, which was originally projected six hundred feet in depth from slope stake to the bottom of the canal, was constantly sliding and would in itself have rendered the sea-level canal an impossibility. If it had been solid rock the difficulty would have been simply one of money, but unfortunately there is nothing solid about it. Any rock that there is in Culebra is so fissured by "clay backs" that no dependance can be placed on the slopes—hence the constant slides which the French, and later the Americans, experienced during construction and even after the canal was opened to operation.

The working force was normally twenty thousand men, of whom probably no more than twelve thousand would ever be at work at any one time; the remainder filled the sick lists and convalescent report. In spite of these disabilities, life was gay and amusing. To lose the number of one's mess was regarded as the most natural thing in the world. Salaries were high, living was fairly cheap, and it was a case of "go it while you are young."

Mr. Benn's article on the Panama Canal omits all mention of the Panama railway which was built to help the gold rush to California and to avoid the over-land trail across North America. The railway was finished in the early 'fifties, Vanderbilt and Aspinwall being the two leading financiers in the scheme; remarkably far-seeing men they must have been. The railway is reputed to have paid fifty per cent per annum on its capital for some years. The story goes that there was a Chinaman buried for every sleeper along the length of the railway: no other labour could endure the climate. It was a most remarkable feat for the early 'fifties, and the financial result was beyond the wildest dreams of those who placed their faith an capital in the enterprise.



BLASTING PONTOON AT MINDI, 1887.

The greatest engineering difficulty was the control of the Chagres River. The attempt to force the river through narrow channels was finally abandoned.

The canal was built by the United States Army engineers. It was carried out with great economy and with the most rigid discipline, and constitutes a lasting monument to the ability and honesty of the men who directed it. The manner in which it is operated to-day is a credit to all concerned. The engineers profited by the experience of the French who had suffered the earlier difficulties and they benefited by the discoveries of Colonel Sir Ronald Ross, who indirectly did more for the Panama Canal than anybody else connected with it.

Following Sir Ronald's discoveries, the United States Army Sanitation Service, under Colonel Gorgas, carried out a most remarkable achievement, practically eliminating the mosquito in the canal zone. The writer, who had been accustomed in the early days of the French canal to work surrounded by clouds of mosquitoes, crossed the isthmus on various occasions during the construction of the canal by the Americans and does not remember having seen a solitary mosquito from Panama to Colon. This speaks volumes for the organization of the sanitation service.

Music: A Triumph of African Art.

By Captain William Hichens.

Late of the Native Administrative Service, East Africa.

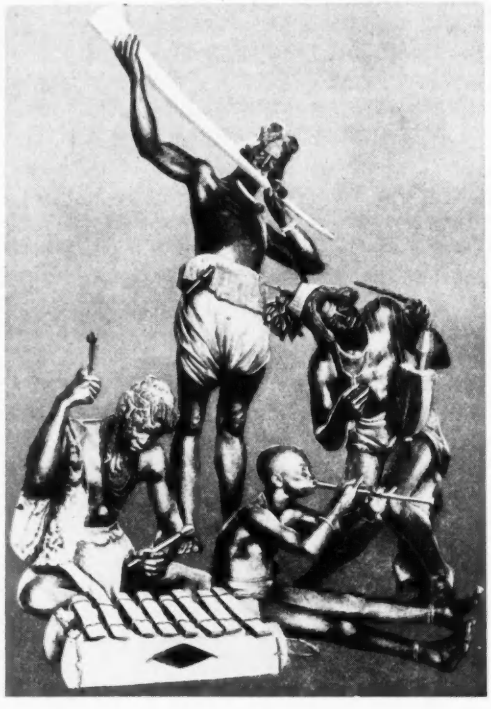
Negro music is the subject of an investigation now being conducted in Africa. Although strange to the unaccustomed white ear, the author has found it singularly perfect in technique, and corrects the popular impression that the native music is jazz. Some of the remarkable instruments are here described.

NEGRO music, as interpreted by the modern dance orchestra, has been one of our post-war infatuations, so that to most people the mention of negro music inevitably suggests jazz. It is thus not surprising to find that the first Press reports of the tour of research into African native music, now being carried out by Professor Kirby of Witwatersrand University, should emphasize the fact that he "has found curious aboriginal affinities to jazz."

Such affinities do exist in African music: in the rhythm of drumbeat and in occasional wild and disharmonic phrases flung from the ground of the melody; and often in boisterous wedding festivals and harvest dances the blare of the long wooden horns known as *mbutu*, breaks into syncopation, stressed by the stamping of the women's belled feet and the piping of breathless warriors. But African music is not jazz, and jazz is not African music.

Music is the foremost negro social art; it is the right hand of the native's social physiology. He is born, named, initiated into manhood, warriored, armed, housed, betrothed, wedded and buried to music; with music his departed spirit is invoked or appeased in its moods. Much of the music, though strange to the unaccustomed white ear, is singularly beautiful and perfect in technique, and there must be few music lovers who would not be moved by such native songs as the Zulu "Ngwe ne ngony ama," a traditional part-song typical of some of the best of native music, in which the voices of the men and women singers rise and wane in successive waves of harmonic melody.

So, too, the most sceptical newcomer to Africa never fails to be impressed by the songs of the canoemen plying their craft on the great lakes and rivers. "My canoemen," says Andre Gide, "began a song. Ah! That Stravinsky might have heard it!" And of the same songs another traveller has said, "In the solitude of the river they have the dignity and grandeur of a liturgical chant." But words cannot conjure the scene or sound of native music, much less can they picture the swish of paddles in the moonlit water which form a harmonic undertone to the clear, mellow voice of the canoe's helmsman as he sings the stanza, followed by the melodic swell of the paddlers' chorus.



NEGRO MUSICIANS.

This group of African musicians, which stands in the Tervueren Museum, shows some of the quaint instruments used in native orchestras.

To know its solemn grandeur one must hear the first high call of the *suka* drum far in the hilltops over the veld, hear the notes of the horns joining one by one in the paean which announces to the spirits of the tribe that a warrior has gone to join their company. The black orchestras with their weird instruments and strange diatonic music make a deep impression on the newcomer to the kraals—the ulele player who wanders from kraal to kraal, musicking the scandal and news

of the day on his five-noted flute, with its *vox humana* effect so perfect that natives can glean the unspoken words from the trill of the music; the wild saxophone-like voice of the zomari; the mellow twang of the herd boy's one-stringed guitar.

Of the numerous instruments played by the African musician, the drum, or tom-tom, is one of the most important, although it is not in fact a musical instrument at all, but a rhythm beater. But no wider proof of the African's musical ingenuity could be asked than that shown by his drums, which are devised to make every kind of sound, not merely by beating them but by stroking them, vibrating their tops with the finger-tips and even making them "breathe" in a way which evokes a series of wheezes reminiscent of the bagpipe.

AN AFRICAN DRUM.

Of the numerous instruments played by the African musician the beautifully carved drum is one of the most important.

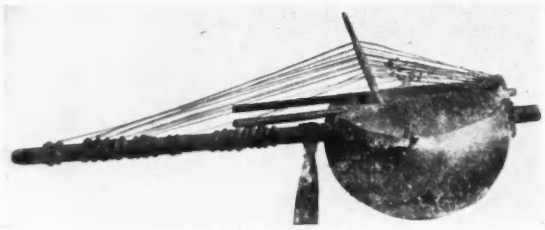
This effect is achieved by a bottle-shaped drum with an aperture in one side and the hollow neck of a gourd fastened with rubber latext to another hole in the other side. When the taut skin of the drumhead is beaten with the hand, air is driven out and at once rushes in again, while the drummer, or rather drummeress, for women in many tribes are the performers, controls the pitch of the drum note by pressure or rapid vibration of her finger-tips upon the drumhead.

Another remarkable drum is the ketet of the Nandi of Kenya, used when the young boys of the tribe take their first initiation rite. It consists merely of a wooden barrel, ordinarily used for the storage of hide garments. Over its mouth is stretched a goat skin upon which is held a smooth, long stick. The performer wets his hands and, rubbing them up and down the stick, produces a lion-like roar. A similar drum is used when Nandi girls are initiated into womanhood, but it is made from an earthen water jar; both drums are taboo to opposite sexes. Women and girls must not look at or listen to the boys' ketet drum, and the boys must make themselves scarce when the women are playing the girls' drum, known as cheplanget.

Probably the earliest native drum was merely a hollow log beaten with a stick, although primitive drums still exist in the Congo, consisting of a goat hide, dried in the sun, which is pegged down over a hole in the ground. The native, however, probably discovered that dry hide whacked with a stick gives out a drum-like sound independently of the hollow log. Banging an ox hide sleeping mat at night to make it emit a rattle and rumble is one native way of scaring away hyaenas and other night prowlers, and often, as with some Kenyan and Tanganyikan tribes, strange taboos are connected with this impromptu bedcover drumming, so that women and girls are forbidden to use it. The native probably linked up the plain drum-hide, held between his knees and beaten with a stick, with the primitive log drum, and so made the hide the tympan of the log. This, the cylindrical hollow log, covered at one end with hide which is usually fixed with small wooden pegs round the perimeter of the drum, is a form common to many tribes.

A more advanced type of instrument is the goblet or kettle-shaped drum which ranges in size from the height and breadth of a man to small hand-drum, such as those which are the personal property of all grandmothers among the Iramba tribe of Tanganyika; they are beaten only by the grandmothers in a special dance to celebrate the birth of twins. In these drums snake skin is used as the tympan. In the more elaborate goblet-shaped drums the drumhead is stitched on with sinews and strips of game hide which are often twisted into long strings running from top to base of the drum, either straight or plaited round it. Again, the drums may be unadorned or carved with exquisite sculptures, as in the case of the Bakuba drum in the British Museum.

Many quaint objects are put into drums by different tribes to increase or vary the sound—balls of hair from the stomachs of lions, stones from the maws of crocodiles, "magic" stones reputed to bring rain or to



A NATIVE MANDOLIN.

Many of the native mandolins are covered with expertly prepared skins and have carefully drawn strings. They are often adorned with artistic carving.

avert disease and disaster, bells, resonant patches and plugs of rubber, and even human tongues. The drums are by no means, as is commonly thought, always "tom-tomed" with drumsticks. Drumsticks are used, sometimes straight and knobbed as we know them and sometimes angular or curved; but many drums, especially those played by the women, are operated by vibration with the fingers. The woman drummer rests the base of her hands on the drumskin and taps, or rather quivers, her finger-tips upon it, and in this remarkable fashion, varying the tension by pressure with the ball of the thumb, she will make the drum murmur, squeak, wail or roar!

But the drum, though such a prominent instrument in the native orchestra, is used to mark the rhythm and not to "make the music." It may and does vary its tone and there may often be a battery of drums of variant pitch; but horns, bells, pipes and a number of curious string devices are the real native musical instruments. The most primitive horn was doubtless that of an antelope or of the kudu, roan, sable, waterbuck or buffalo. The latter is still used in many places both as a wind instrument, when it emits a tuneful blare to be heard for many miles, and as a drum, when it is usually held by old ladies at a dance and vigorously tapped with a stick or a piece of hide. Many tribes use antelope horns with a small mouthpiece cut near the tip, and these give an extremely mellow, deep note.

It is the elephant's trunk that has appealed most to African musical sense; and the mbutu, or wooden horn, carved and shaped from four to five feet long in the style and size of an elephant's trunk, takes the leading part in many orchestras. One may remark here that the chiefs of many tribes employ professional musicians, and every village, however remote, has its own orchestra which, when dance and music are the order of the day, is engaged for the event. Some performers are more expert than others, but nearly every adult native can perform creditably upon the musical instruments of his tribe.

Such an orchestra on the event, for instance, of a beer-dance at the end of harvest, when great rejoicing dances are held throughout the kraals, would consist of a dozen or more drummers, a score or so of mbutu players, some pipers, one or more players of a variety of the zomari (a kind of saxophone), and players of various stringed instruments. Although it might be thought that such an assemblage would produce nothing but cacophony, the reverse is in fact the case. Each mbutu player, performing either impromptu or traditional airs, can produce but one note from his instrument, but the mbutu are of different tones and each player picks up his cue and plays the exact note at the precise moment required. In general effect, such a band resembles one of our mixed brass and string bands.

Its string instruments consist of the native equivalent of lyres, mandolins and violins, except that in the last case the single string is plucked and not bowed. The fact of the instruments being primitive—for they may be merely gourds cut in half, covered with a skin and bored for sticks which pass through the soundbox to support the strings—in no way daunts the native musician, who conjures from his instrument melodies of surprising sweetness. Not long ago in one of the most primitive tribes near the shores of Lake Eyassi I came across a "guitar" player whose instrument, known as a kizomo, was a battered calabash with two rough-hewn sticks as a frame for the strings which were of antelope gut. He held this musical triumph between his feet as he sat on the ground and proceeded to play one of the sweetest and most haunting melodies that I have ever heard, while a number of young girls performed a singularly graceful "dying swan" dance.

WOMEN DRUMMERS.

The drums, which are usually played by women, are devised to make every kind of sound, and are even capable of producing notes reminiscent of the bag-pipe.

Not all the native instruments are as crude as this performer's calabash; many of the guitar, mandolin and lyre-like instruments are carved from the wood in beautiful form, covered with expertly prepared skins and carefully drawn strings, and often adorned with carving of high artistic skill. They vary in form from the one-stringed fiddle, often a simple hunter's bow with a gourd thonged to it as a soundbox, to the elaborate mandolin-like *osdu*. Almost every tribe has its characteristic instruments and equally its traditional music and song; and, as with us, the music is appropriately adapted to the occasion. The jovialities of the beer-dance find expression in jigging airs and lyrics reminiscent of the music-hall, but no one, even of the most unmusical ear, could ever mistake the fine tambika songs with their impressive horn fanfares, played when the elders of a tribe approach the dwellings of the tribal spirits to invoke their power, for anything but the solemn and sacred chants of supplication that they are.

An African Sultan's Saga.

It is noteworthy, too, that the finest and almost the only fragment of true East African native traditional literature extant consists of a saga of song and lyric composed by one Sultan Liongo Fumo, who ruled at Shaka on the Kenyan coast in the early sixteenth century. This saga is a rhetorical song-cycle of great poetic and philosophic beauty. It is not unlike the Song of Solomon. From it one learns that the orchestras of Liongo's time must have been magnificent. No doubt they were influenced by Arabian musical culture; but the essence of the saga is purely African. Liongo sings to his minstrels, "Go ye ahead upon the way, O minstrels, as bright-hued lizards running!" And he sings also of ivory trumpets, brasses and cymbals, bells and drums, castanets and great elephant-tusk horns. These wonders have gone, but Liongo's songs remain.

Much interest has been shown during the past few months in native music. Professor Kirby, who has conducted an extensive tour of research in Zululand, the Transvaal, the Kalahari and Bechuanaland, has collected over a hundred types of musical instruments and has recorded, some for the gramophone, a great deal of indigenous music. His conclusions have yet to be made known, but it is interesting to note that several of the leading British, French and German gramophone companies have published during the past twelve months records of a large number of African songs and musical pieces. Among the records music lovers and students of African culture will appreciate a very fine series of Zulu traditional songs and dances and a series of Swahili, Chinyanza, Kizaramo and Kirufiji songs and dances.

At present, when the mentality of the African is the subject of much political discussion, this music throws a new light upon the native life which is so often regarded as a kind of recently industrialized barbarity. It reveals an aesthetic and emotional phase of native life closely akin to our own. The musical white man, although he may not understand a single word of any black language, will be at no loss to translate the emotion of the savage music, sad or gay, languorous or warlike, which is now being brought from the heart of the wilds into our gramophone cabinets.

Correspondence.

THE INDONESIAN RACE.

To the Editor of DISCOVERY.

SIR,

In view of the fact that our knowledge of the Indonesian race has hitherto been regarded as largely conjectural, I was interested in Mr. W. R. Price's recent article on the Island of Formosa. Mr. Price writes that the Indo-Oceanic Caucasians reached India in 2500 B.C. and finally migrated eastwards in A.D. 450; further, that they had a route of migration north-eastwards from India. This suggestion is interesting, but I have been unable to discover evidence of the fact that their occupation of Formosa and the highlands of Yunan was the result of a north-eastward migration from India. The suggestion that these people were the ancestors of the Hindu race appears to be equivocal; and if Mr. Price refers to the Indo-European race which is generally regarded as having introduced the Hindu religion into India, I think that 2500 B.C. is too early for a settlement in the plains of the peninsula. Mr. Price writes that the hunting, pastoral and agricultural phases are successive stages through which primitive man has passed, but I do not think that the pastoral stage can be definitely regarded as a universal step from the hunting to the agricultural.

Yours faithfully,

Simla, India. J. H. HUTTON.

THE SUN A BRILLIANT GREEN.

To the Editor of DISCOVERY.

SIR,

The recent correspondence in *Discovery* regarding the Green Flash recalls a curious incident of some weeks ago. It was about noon, but there was an overhead mist and the sun could easily be seen with the naked eye as at sunset. As I watched the sun, the steam from an engine rose directly in my line of vision, and to my surprise the sun appeared a brilliant green; this remained more or less constant, varying slightly with the density of the fumes. It occurred to me that the vapour was acting as a spectroscope, and that I was seeing the coronium only, but since the sun appeared as a perfect disc, and no corona, this was evidently not the case.

Yours faithfully,

Hull. P. D. HOLDSWORTH.

Drifting Meadows of the Sea.

Systematic study of oceanography commenced with the voyage of the "Challenger," the British research ship which set out on a voyage of investigation in 1873. More recently considerable progress has been made in America, and the results of research at the Carnegie Institution of Washington are here described.

SINCE the days of the *Challenger*, the famous research ship equipped by the British Government and sent in 1873 on a three-year cruise of all the seas, the study of oceanography has held a fascination for the scientist. For many years the physical and chemical composition of the ocean has been the subject of systematic study in laboratories and during the course of scientific expeditions, and in the pursuit of investigations the Carnegie Institution of Washington has contributed both directly and indirectly during the twenty-five years since its foundation.

Soon after its establishment, the Institution erected a laboratory on an island in the Gulf of Mexico and equipped it for the study of the sub-tropical ocean. The Department of Terrestial Magnetism, under the direction of which the *Carnegie* was built and operated, has also devoted considerable attention to problems in this field. Although the vessel was constructed and sent to sea primarily for the study of magnetic phenomena, it was completely overhauled in preparation for its last voyage and the latest type of oceanographic apparatus was installed. Moreover, the staff of the vessel included scientists who were trained in the science of oceanography. The results of the investigations are now being prepared for publication.

Research in America.

Dr. Albert Mann, a member of the Carnegie Institution staff, has devoted many years to the study of a group of single-celled plants known as "diatoms," and described one important aspect of the work in *Discovery* a year ago. These organisms have their growth in the sea and constitute the basic food supply of fish. Since 1906, the Institution has made an annual grant towards the work which is being carried out to determine the laws governing circulation in the atmosphere and in water. This work has proved to be of outstanding importance, for upon it are based certain theories, now widely accepted, which relate to currents in the air and in water. Indeed, investigations have reached a point when they are likely to prove a valuable contribution to the scientific basis which is being sought for weather forecasting and for the anticipation of probable changes in the climate of continental areas. An important branch of the work deals with the movement of ocean waters in vertical directions; these studies can best be understood when considered in their relation to the distribution of food materials required by the great communities of marine plants and animals which drift in the open sea.

Abundance of "Diatoms."

The plants of the drifting group, largely "diatoms," occur wherever fresh or salt water is found. They are most abundant, however, in cold latitudes. When conditions are favourable, the tiny plants multiply with such rapidity that as a result the water is frequently coloured for an area of many miles. Each single-celled plant divides into two cells every few hours, and the process continues indefinitely, until within two or three weeks the number has multiplied enormously. Indeed, it has been calculated that a single individual will normally develop into a billion within a month.

So abundant, in season, is the growth that observers working in the Baltic have reported finding a thousand individuals in no more than a thimble-full of water. Catches in the Baltic and North Sea are on record where the number of individuals per cubic metre of water was as high as 7,800,000,000. Estimates based upon test catches in the English Channel off Plymouth indicate that the annual production of "diatoms" underneath an acre of surface water at that point amounts to five and a half tons. Observers have also reported that in regions of melting ice on the borders of the polar seas the plants form bands sometimes fifteen feet thick which frequently extend for hundreds of miles.

A careful examination of the sea off the coast of Maine suggests that there is no reason to suppose that the fecundity of the plants in this region is any lower than that of the plants of the North Sea or of those of the still more prolific waters of the West Baltic. It is suggested that when the numbers are expanded from the trifling bulk of a cubic metre of water to the 36,000 square-mile area between Cape Cod and

Nova Scotia, the area covered in recent studies, and to a stratum at least twenty metres thick, they become too vast for the human mind to grasp.

Each " diatom " secretes a protective covering of pure silica, somewhat as an oyster secretes its shell, and the crystalline box which houses the tiny organism is indestructible. When the individual plant dies as it does in a few days, for its life-span is very short, its glass-like shell-case, a thing of exquisite beauty when seen under the microscope, sinks to the bottom of ocean or lake. In this way great deposits are formed which, in turn, through the earth's convulsions, are elevated above sea level in many cases, thereby making available for man's use great stores of diatomaceous earth.

Commercial Uses.

In addition to secreting a shell-case of silica, which is being put to many commercial uses, the diatom stores up oil in its living substance. Indeed, from five to forty per cent of its bulk consists of oil which is released when the organism dies and disintegrates. The oil, which is the plant's reserve of food, is believed by many scientists to have accumulated in immense volumes during the ages and to have been converted into petroleum.

Unlike their earthbound cousins, these plants require no such specialized structures as roots with which to seek out the chemical elements they need, nor supporting stalks to lift them to a place in the sun, for they lie suspended in the upper levels of the water, the zone penetrated by solar radiation, and they absorb their nourishment from the fluid in which they are immersed. They are true plants, however, for like land plants they possess the green chlorophyll which gives them the power, by the energy of sunlight, to convert the nutrient salts and gases into the substances which animal tissues require.

The great areas of drifting plants have been called the " meadows of the sea," and in the " meadows," in appropriate season, appear incredible numbers of tiny animals which there find a bountiful supply of food ready at hand for the taking. Represented in this hungry horde are the young of many of the fishes and of almost every group of the invertebrate animals. Even the larvae of those animal types which, like the barnacles, spend the days of adulthood fastened to rocks and ocean bottom, feed upon the rich crop of " diatoms." But by far the most numerous of all is a group of small crustaceans, shrimp-like animals known as " copepods."

While many of the " copepods " are large enough to be seen, a microscope is needed to determine clearly their structure, which is singularly beautiful in many species. Some are remarkably transparent, while others are strikingly coloured. One species of this group, *Calanus finmarchicus*, occurs in remarkable numbers. A student of oceanography reports that on one occasion he towed a net, which had a circular opening of over three feet in diameter, through the sea off Cape Cod for fifteen minutes and obtained over two and a half million individuals.

The innumerable throng of diminutive animals, together with the minute plants upon which they subsist constitute the passively drifting life, the so-called planktonic life of the sea, and it is in these marine meadows that the food-chain begins which links together the whole of the aquatic world.

First of all are the " diatoms " and other chlorophyll-bearing unicellular plants. These are the alchemists who convert elements of the inorganic world into food fit for the planktonic animals. Next is the horde of " copepods " and other small animal organisms which feed upon the rich pasturage. These in turn are devoured by multitudes of jellyfish, sea worms, free-swimming snails, shrimps and crab-like animals of various shapes and sizes. This great company is similarly preyed upon by various fish ; and so on until the entire life of the sea is bound together into a vast network of complicated relationships.

The study of the inter-dependence of plankton-communities began with the voyage of the *Challenger*. Aboard the vessel were some of the most distinguished scientists of the day who brought back for study a large collection of plankton obtained from all the seas. Indeed, so vast was the programme of observation and so intelligently was it executed that this voyage may properly be said to have laid the foundations for the science of oceanography.

A Puzzling Aspect.

One of the aspects of planktonic life which has puzzled scientists relates to the marked variations in its abundance. Observers have reported that during the early spring there is a great outburst of life among the plants which is quickly followed by an amazing increase of animal-plankton. By May or June drifting plants decrease considerably in number, and the dependent animal population also falls. There is a period in the autumn when another exuberance occurs which, however, is not as great nor as long lived. In turn, this is followed by comparative inactivity, which lasts throughout the winter and on into the spring, when the ever-recurrent cycle begins again.

Until recently the causes for these changes were obscure, and even now, despite the exhaustive study given to the subject, there are many points not fully understood. It is clear, however, that a hereditary factor is involved, an inner protoplasmic urge, so to speak, which finds expression in the seasonal cycle and which is common both to the plants and animals of the planktonic world. Without doubt the organic cycle is in part a response to something inherent in the organisms themselves. But it is also clear that since all the animal life of the sea is ultimately dependent upon the drifting unicellular plants, other causes for variation must be sought, more especially among the factors affecting the physical environment of the plankton-plants. The most important of these are, apparently, the presence or absence of sunlight and the plenitude or insufficiency of the inorganic substances which the plants utilize.

It is in accounting for the transfer of the food materials which the plants require, that the study of vertical movement in ocean-waters can be most clearly grasped and its role most fully realized. The substances which are essential to the plankton-plants are carbon dioxide—a gas constantly given out to the surrounding water by all the marine animals—and those chemical compounds which are known as nitrates and phosphates. "Diatoms" also require silica for their shell-cases. These materials are present in ocean waters as solutions, but they are so dilute that there are few parts of each in a million parts of water.

As the nitrates and phosphates are the principal ingredients of the artificial fertilizers prepared for the farmer who seeks to increase his crops, so they have been called the fertilizers of the sea, for their presence in abundant quantity has a similar effect upon the crop of plankton-plants. An important external cause, therefore, for variations in planktonic activity, assuming that sufficient sunlight obtains, lies among the factors affecting the distribution of these manurial salts.

Indispensable Substances.

In a recent lecture at the Carnegie Institution, Dr. H. V. Sverdrup, an expert in the science of oceanography, explained that, besides the major components, which together determine the salinity of the water, there are always present minute quantities of other compounds, which are of no importance to the total salinity of the water but of the greatest importance to the organisms in the water, for example, the nitrates, phosphates and silicates in the sea. These substances are indispensable to the life of organisms, especially the nitrates and phosphates which have been called the fertilizers of the sea.

Chemists have only recently succeeded in determining these imperceptible quantities accurately, and our knowledge of the distribution of sea fertilizers is therefore still scanty. But the observations from the coastal waters of Europe and the South Atlantic, and recently the observations from the Pacific which were made from the *Carnegie*, have already shown that the content of phosphates and nitrates varies much from one place to another and that the variation with depth is extremely large, the content being small in the surface layers but great in the deep water.

Life in the Upper Layers.

Considering the great variations it is evident that the transfer of these substances from one water layer to another is of eminent importance. An intensive development of organisms takes place only in the upper layers of the sea, because the presence of light is an essential condition for the development of the plant life which forms the basis for the animal life; and a sufficient amount of light does not penetrate to great depths.

The small amounts of phosphates, nitrates and silicates in the upper layer must be attributed to the circumstance that these substances are there being used for the building up of organisms, but since the building goes on constantly, it must also be assumed that a regular transfer of fertilizers from the deeper layers takes place. The same substances, on the other hand, are brought back again to the deep water when the dead organisms are sinking. The organic substances are then decomposed and the components dissolved in the water. In addition to the nitrates, phosphates and silicates, mention must be made of the important part which is played by oxygen and carbonic acid.

Three factors tend to increase the amount of oxygen in the sea, namely, the absorption of oxygen from the atmosphere, production of oxygen during the assimilation processes of the plant organisms, and transfer of oxygen from another layer. During the second process carbonic acid is assimilated and transformed to organic substances. The oxygen-content within a given body of water decreases under the action of three factors, namely, respiration of the animals which produces carbonic acid, the decomposition of organic matter which in the last stage also increases the amount of carbonic acid, and finally the transfer to other bodies of water. When studying the oxygen and carbonic acid content of sea-water it is, therefore, also necessary to consider the transfer

of the dissolved gases. This means that we have to deal with the same problem as in the case of the distribution of nitrates and phosphates. We encounter the same problem when studying the conduction of heat in the sea or when discussing the currents which are produced by wind or the currents in the vicinity of the bottom.

The abundance of plankton-plants in the spring quickly depletes the supply of nitrates and phosphates in the upper layer of water ; this is the layer penetrated by light and consequently the only one in which the plants can grow. Were there continuous transfer of these materials from the deeper layers to the plant zone, growth would doubtless be more nearly continuous also, but Dr. Sverdrup points out that no such continuous transfer takes place ; and the reason for this lies in the fact that the surface layer of warmer, lighter water is separated from the bottom layer of colder, heavier water by a narrow transition-layer which acts as a " discontinuity-layer," preventing transfer of the materials which the plants require.

In discussing this phase of the investigations, Dr. Sverdrup visualizes a layer of light water above a layer of heavy water, the two layers being separated from each other by a thin layer of transition. If a particle moves upwards from the heavy layer, it becomes surrounded by much lighter water and drops back again to the layer from which it came, on account of the action of gravity. A particle which moves downwards from the lighter layer is, on the other hand, driven back again to that layer. As a consequence, only very small eddies develop at the boundary of the two fluids, and the transfer of kinetic energy or dissolved substances from one layer to another is small. A layer of transition which is so sharply developed acts as a surface of discontinuity, and the two layers—the light surface and the heavy bottom—move and behave as if they were separated by a solid wall. No energy or heat, or any of the substances which are dissolved in the water, are exchanged between the two layers.

The Plankton Community in Spring.

Since no fresh supply of nutrient material is to be obtained from the bottom layer, therefore, plant activity dies down after the first outburst for lack of food. During the autumn, the surface layer cools and the temperature of the water-column becomes more nearly uniform throughout. In such a case gales readily effect a mixture whereby fertilizers are brought to the surface, when a quickening of planktonic life occurs which rapidly subsides as the light rays of the sun become too feeble for effective utilization. By the time spring has returned, and with it increase in the penetrating power of the sun's rays, the surface layer will have become replenished once more. Thus the stage is again set for the great spring surge of the plankton-community. While in general the presence of the " discontinuity-layer " tends to prevent the free mixing of the layers, nevertheless in certain regions local conditions obtain which enable the bottom waters to break through to the surface, carrying with them their content of nutrient salts and gases. Thus a deep-water current striking a coastal shelf will be forced upwards. In such regions the planktonic life is exceptionally rich.

Influence of the Weather.

Again, strong off-shore winds, if they blow long enough, will drive the surface water out to sea, and this, in turn, is replaced by water welling up from below. In this case response can again be detected in planktonic activity. On the other hand, it is said that a prolonged period of fine weather may cut off the food supply of plankton-plants, thus resulting in an appreciable lessening of the plankton crop, a condition which tends to drive the food fishes away from their accustomed feeding grounds. This, in turn, seriously affects the size of the market catch of the fishermen. The physical properties of the sea, which affect di-tribution of the essential inorganic substances utilized by the plants, are thus seen to play a vital part in rendering the sea a fit place for life. But the problem of inter-relationships is a complicated one involving other factors than that of the vertical movement of needed material. Only one side has so far been treated of the problem which deals with the conditions for development of organisms in the sea, namely, the vertical transfer of essential substances from one water layer to another on account of eddy-conductivity.

In a comprehensive discussion one would also have to consider a number of other factors which are studied by the physical oceanographers—for example, the seasonal variations of the stratification of the water, the variations in temperature, the horizontal and vertical transport of water by means of currents and the penetration of light into the sea. This enumeration may give an idea of the intimate contact among the various fields of research within oceanography. It is clear that the results of widely different investigations must be correlated in order to gain a knowledge of the sea which may satisfy our desire for information, and form a sound basis for application to the numerous problems dealing with the utilization of the quantities of food which are available in the sea.

Book Reviews.

The Zimbabwe Culture. Ruins and Reactions. By G. CATON-THOMPSON. (Oxford University Press. 25*s.*).

It is difficult to preserve a sense of proportion in attempting to estimate the value of the author's excavations in the ancient buildings of Rhodesia from April to September, 1929. Not only has she confirmed and extended the conclusions at which Dr. Randall-MacIver arrived after his investigations in 1905; she has laid once and for all the ghost of a controversy which has hovered over the ruins of Zimbabwe for a quarter of a century.

The circumstances which led the British Association to invite Miss Caton-Thompson to conduct excavations in these remarkable ruins have already been described in *Discovery* (February, 1929). It will suffice here to recall that Dr. MacIver, on the occasion of the Association's meeting in South Africa in 1905, conducted excavations which demonstrated the mediaeval age and indigenous origin of the Zimbabwe culture; but his evidence failed to convince the upholders of the opposing theory that the buildings dated from somewhere between 2000 B.C. and the Christian era, and were the work of Sabaean and Phenician. Dr. MacIver's methods were impugned and his results were challenged on the ground that his most decisive evidence came from a site which was admittedly later than Great Zimbabwe. As controversy had raged for twenty-four years with no hope of approach to a decisive resolution of the problem, the British Association decided to undertake the investigation once again *de novo* and invited the author to carry it out.

The results of the excavation, which this book embodies, have been familiar in broad outline since the author presented her report to the British Association at Johannesburg in 1929. In the subsequent visit of members of the Association to the site—among them expert archaeologists both British and South African—it was possible to verify the accuracy of the report from the workings which had been left open for this purpose. The mediaeval date of the buildings was fully confirmed; but thanks to the discovery of beads—a class of evidence, as the author points out, not available to Dr. MacIver—it was possible to carry that date back some four centuries earlier than it had been fixed by him. The beads, current in the East and contemporarily in use at the time of the erection of the buildings, as was proved by the position in which they were found in numbers below a cement floor, fixed the date as not earlier than the seventh and probably not earlier than the ninth century of the Christian era. Nothing was found among the different classes of objects—pottery, bangles, iron weapons, etc.—to suggest anything but an indigenous origin. There is no indication even of foreign influence. As so much attention has been centred in the past on imported wares, Chinese and Persian, it is of interest to mention the discovery in a mound outside the East Ruins of a piece of celadon ware of the Sung Dynasty (thirteenth century). Apart from the beads, this is the oldest imported article ever found.

The author of this book describes in detail her excavations at the Maund Ruins—chosen as an untouched site contemporary with the so-called "temple," the Acropolis, in which the beads, crucial evidence for dating, were first found—her tunnelling under the great conical tower, and the excavations on the Plateau. Several outlying sites were excavated, including the Dhlo-Dhlo ruins examined by Dr. MacIver, from which the somewhat astonishing result was obtained that building was still going on until as late as perhaps 1700. The author is convinced of the indigenous origin of the Zimbabwe culture. On the negative side nothing has been found inconsistent with such an origin, while on the positive she offers a number of suggestions as to affinities of certain characteristics, which, to say the least, are attractive. It will be the future task of students of African culture to follow them up.

The book is described as a student's record for students. The lucid and incisive exposition, the profusion of illustration by plan and photograph and the intrinsic interest of the subject matter will earn and hold a wider public than the specialist. On the archaeological side, so far as is humanly possible, the author's work is final. It leaves for future study a problem no less fascinating—the causes which led to this remarkable development in African culture.

Recent Advances in Entomology. By A. D. IMMS. (J. & A. Churchill. 12*s.* 6*d.*).

Within recent years it has become more and more apparent that in the study of insects as of other animals the environment must be studied too. Even such notorious insect pests as the cotton boll-weevil and the European corn-borer are not isolated entities with an undue capacity for destruction, but are part and parcel of a vast physical and biological complex. With the realization of this there has been a definite advance in the study of insect physiology and ecology, an advance which, because it has taken place at scattered points on a wide front, has failed to receive adequate recognition. This book now summarizes the main lines of this recent advance and is especially welcome for that reason. It may be considered in the main as comprising two sections, each dealing with different aspects of recent work.

The first section, comprising Chapters I to VII, deals with various aspects of morphology and metamorphosis, with palaeontology and with the more fundamental aspects of behaviour. The second section deals with the applied aspects of entomology, with ecology, parasitism and with what is loosely described as "biological control." In the morphological chapters such subjects as the segmentation of the head, wing venation, the metameric appendages and the genitalia are discussed and more recent work is summarized. These are most useful chapters, especially for the advanced student. Not a few, however, will wonder why these chapters and that on palaeontology could not have been incorporated in the second edition of the author's "Text Book of Entomology" only recently published.

In dealing with metamorphosis the author calls special attention to Berlese's theory, which he considers has been neglected by most workers, although he himself called attention to it in his text-book of 1924. The theory is briefly that in the Hemimetabola three important stages of embryonic development, namely, the protopod, oligopod and polypod, are passed within the egg, but that in the Holometabola the young insect leaves the egg before these stages have been completed, some insects emerging even as veritable embryos. On this basis Berlese and Imms would compare the larvae of the Holometabola with the embryonic phases with which they appear to correspond. Thus the caterpillar with its abdominal legs is to be correlated with the polypod stage, while the larvae of most of the Coleoptera are to be correlated with the oligopod phase of development.

The adoption of this hypothesis of Berlese may be helpful, and the author points out that several recent workers have contributed facts bearing upon it. Among them he cites Eastham, but he does not state that Eastham in the paper cited—that on Sphaenoserphus—does not support Berlese's hypothesis. The chapter on Palaeontology is especially welcome because the best texts on that subject, those of Handschin's "Fossilen Insekten" and his "Palaeontologie" in Schroder's "Handbuch" prove too much for the average entomological student to whom German is still a difficulty.

The second section of this book demonstrates very clearly how great is the need for the study of insect physiology and ecology. This section is the more interesting portion of the book, and when one considers the ground covered and the variety of subjects dealt with—from vitamins to the control of noxious weeds—it is extraordinarily well done. The only adverse criticism one could offer is that these chapters are so packed with facts and so condensed that they are at times almost overwhelming. On the other hand they are so carefully thought out and planned that it is remarkably easy to return again to difficult points and recapture the thread of the discussion.

Dr. Imms is known to us as one who has, perhaps more than any other English entomologist, kept up the standard of entomology and has shown that it is more than an amateur's hobby and more than a branch of applied geology; this book strengthens his position and enhances his already high reputation.

Bird Life in Devon. By W. Walmesley White. With a Foreword by T. A. Coward. (Jonathan Cape. 7*s.* 6*d.*).

In his foreword to this book, Mr. Coward says of some writers upon birds that they are poets in spirit. To them "the bird is more than an interesting object to be minutely described; it is part of a whole, and that whole presents a picture which necessitates some recognition of all its parts." This is true of Mr. White, and it is this that gives his book its essential charm. Throughout its pages the reader finds much original observation; the author imparts to us his unique knowledge in vivid and graceful English which is refreshing after the paralysing dullness of some ornithological treatises.

Mr. White has observed the growing tendency of ravens (noted also in other parts of the country) to return to their old tree-nesting habits: he knows of such nests in oak, larch, spruce and Scots fir. His quick musical ear has enabled him to detect curious variations in the songs of individual wood-warblers. He is of opinion that the red-backed shrike's larder does not usually begin till the young are a few days old and continues only until some days after the young have left the nest. This confirms our own less thorough observations on the same point. In the cirl bunting's song the author has sometimes detected an alteration in the pitch from lower to higher, and believes that such change denotes agitation. He is, in our experience, correct in stating that the nest of this species is usually situated not very high from the ground; we have twice found nests at as high a level as four feet six inches; but these were exceptional. As to the woodlark's singing at night, it is suggested that it is an individual and not a constant habit. Probably this is right, but of those we have observed the majority are occasional night singers. The author also writes with originality upon the diving of gulls, the song of the nightjar, and the increase of starlings. There is an interesting chapter on mimicry and freak songs, and he shows sound common sense in his treatment of the thorny subjects of protection, and the interference with the balance of Nature.

We cannot omit a short appreciation of the book's literary merit. Whether he knows Devon or not, the reader will peruse these pages with delight; they savour of the salt sea, the windy moor and the wooded coombe, and bring vividly before our eyes their winged inhabitants. It is, as Mr. Coward points out, a mistake to say that an author has the spirit or style of Jefferies or Hudson. Mr. White is no imitator: his virtues are his own; but he belongs to the same school as these writers; there can be no higher praise. Among the photographs we would specially commend Mr. A. M. C. Nicholl's "Buzzard alighting," a very beautiful and instructive study.

A Short History of Biology. By Charles Singer. (Oxford University Press. 18*s.*).

The most valuable feature of this admirable book is the way in which the subject is presented. It is a comparatively simple matter to write a history of science as a chronological sequence; it is also easy to write a discursive work on the subject that is invalidated by personal emphasis and idiosyncrasy. It is by no means easy, however, to retain at once the true historical method and to present an accurate and balanced delineation of the unfolding of the subject as a whole.

The history of science is a specialized study of the greatest importance, but owing to the stringent demands which it makes on general erudition and scholarship its professors are all too few. Dr. Singer is a learned historian. He never falters in carrying out his plan and he develops his subject with a lucidity born of expert technical knowledge. He entirely avoids irrelevancy and pedantry. In this book the author traces biological progress from the point of view of the emergence of modern problems. In the introduction he outlines his plan in a clear and interesting manner, and from the first chapter we are shown how biological science has grown largely because new problems are the immediate result of extended enquiry.

Until the dawn of the inductive method in science at the beginning of the seventeenth century the profound influence of Aristotle had remained the basis of all scientific knowledge; nevertheless, its vitality was such that it produced in the biological field such monumental figures as Leonardo, Versalius and Harvey. Subsequently, of course, the whole character of scientific research changed and when men came to compare the written word with observed phenomena an entirely new vista was progressively revealed. The telescope and the microscope provided undreamed-of facilities for observation and the work of Newton first demonstrated the beauty inherent in the conception of universal law and order.

It was inevitable that scientific specialization should follow, and after a very considerable time it was realized that this intensive method of research was to lead the enquirer back to the essential appreciation of close relationships and ultimate unity in the formulation of the large scientific problems. It is the privilege of the historian to show these things in such a way that the development of science may be seen not only in relation to its own specialized branches but also in its right perspective regarding the general scheme of things—and right well has Dr. Singer performed the task. In this book he has dealt particularly with biology, but it is to be hoped that he will now attack the larger problem and provide us with a history of science as a whole.

It is lamentable that in the teaching of science, especially in the more elementary stages, more use is not made of the

specifically historical method. The reviewer remembers with pain his own early difficulties with names, formularies and principles in this same science of biology which could have been taught so much more rationally and thoroughly if an historical setting had been used. As the author truly says in his introduction, "L'histoire de la science, c'est la science meme." Teachers should emphasize this truth and extend its application far beyond the limited view-point of present activity.

Such a book as this cannot fail to be of the utmost value to the student of biology and should be a compulsory text-book in the degree curriculum. It contains one hundred and ninety-four exquisite illustrations, and the non-technical reader will find the book more engrossing than most novels.

Jungle Ways. By W. B. SEABROOK. (Harrap. 10*s.* 6*d.*).

This entertaining book describes a journey through French West Africa from the Ivory Coast to Timbuctoo. The author was fortunate in gaining the confidence of the natives, and was thus enabled to witness many remarkable practices. The book is divided into four parts: the first deals with magic and sorcery among the Yafouba; part two contains a description of cannibalism as practiced by the Gueré tribe; the third part describes a visit to Timbuctoo, and the book concludes with an account of the Habbé cliff dwellers, one of the least known races in west Central Africa.

On the Ivory Coast the author claims to have encountered a case of "authentic, actual bewitchment." A fisherman found that he was no longer able to catch fish. "The whole village believed that he was bewitched, and I believed it too; I mean that I believed it literally, without qualification of any sort." A trial by poison followed to discover who was responsible for the fisherman's plight. The trial consisted in eighteen members of the tribe, including the fisherman's wife, partaking of a specially brewed poison. After the witch-doctor had called loudly upon the Fetish, the wife threw herself on the ground, "writhing and screaming incoherently" and thus proving her guilt of the bewitchment.

There is an interesting account of cannibal customs in the Gueré Bush. Questioned about the "rules of the game," a native explained that things had changed of late and cannibalism had become somewhat "corrupt" since the arrival of the white man's government; the whites could not always understand the difference between honest cannibals and the criminal class. The honest cannibals had a code of honour of their own; thus, men slain in battle were legitimate game, as was the hostile or unfriendly neighbour ambushed and taken on the trail. But to kill one's own for food or to kill a wayfaring stranger who came legitimately in peace was punished by the natives themselves before the French ever came to the Ivory Coast.

The author numbered among his experiences the doubtful privilege of eating human flesh; he thus claims to have learned "the empiric truth on a subject concerning which much nonsense has been talked." Mr. Seabrook clearly relates this experience with sincerity, but there seems to be no proof of whether the meal was indeed of human flesh. "It was like good, fully developed veal," the author writes; and since the native cook might quite easily have brought him animal flesh under the pretence that it was human, the meat quite probably *was* veal.

If the book contains little new information, it is certainly more entertaining than most of its kind. The author is a keen observer, and while his literary style might be improved, he recounts his adventures with a modesty which is refreshing in an American traveller. There are a number of unique photographs and a map showing the author's route.

The Physical Properties of the Soil. By BERNARD A. KEEN, D.Sc. (Longmans, Green. 21*s.*).

It is very gratifying to students of soil science to find that Dr. Keen has at last been able to fulfil his long-standing promise to produce this book. There is nowhere else in the English language a similar account of the present position of this important branch of soil study. The historical introduction, combining a brief account of the types of implements which farmers have used over many centuries with the earlier study of their effects on the soil, is both fascinating and useful. One can only regret that it was not possible to include some photographs or diagrams of the various implements referred to and thus to facilitate the reading of this chapter.

Dr. Keen is probably at his best in the chapter which deals with the mechanical analysis of soil. This study has been developed in recent years by so many workers in so many different ways that a concise account of the present position is by no means easy to write. The author is very wise in not adopting either a rigidly historical or a scientifically logical presentation of this chapter. The combination of the two makes it much easier to understand the present position and to appreciate all that has led up to it. It is inevitable that a large part of the book deals with soil water and its relation to the solid particles. The chapter on water distribution and movement is a little disturbing and perhaps not quite so convincing—at any rate on a first reading—as the remainder of the book. Time-honoured theories are disposed of without anything that can be concisely described to replace them. That, however, is no fault of the author, but rather a fact of the present position. The relationship of soil particles to water is dealt with in three chapters. An interesting chapter is included on cultivation, including an account of the well-known Dynamometer work that has been carried out at Rothamsted, and a discussion of the behaviour of different types of cultivation implements.

The general agricultural student will probably find this book too advanced and mathematical for his use, although he should derive a great deal from the chapter on cultivation. Students specializing in agricultural chemistry or physics, teachers of the subject and research workers will undoubtedly come to regard it as indispensable. It is well written. The diagrams, nearly a hundred in number, are good and the book appears to be well indexed. In addition there is a very excellent bibliography. The book should receive a very cordial welcome from the serious student of soil science.

The Poetic Impression of Natural Scenery. By VAUGHAN CORNISH. (Sifton Praed. 6*s.*).

"In such surroundings and on such days the soul is satisfied and at peace. . . . We must seek the source of the day's happiness in those satisfactions of the visual sense which create an emotional state." This passage, from the author's description of the English landscape in February, gives the key to his book. He takes us through the English seasons, and then we follow

him on an Odyssey through Switzerland, across the ocean to Suez and Singapore, then on to the West Indies, South Africa, and so to Niagara and Canada. In exquisite prose he describes the scenery of mountain, sea and lake, of starry heavens and snowy wastes. But it is the "emotional state" evoked by these sights which appeals to him. In an oak coppice in May, "Nature was no longer an environment, for suddenly, caught up and incorporated, I was one with the world around." And again in June, in the Weald of Kent, amid the songs of the birds, "the conception impressed by the surrounding scene was that of a creative not a created world. There was no suggestion of beginning or end, but a vision of life without beginning and without end, time flowing on for ever, a picture of eternity alternative to that of a timeless state."

Our receptivity to the silent speech of Nature depends upon our moods, or even upon our physical condition—a somewhat humiliating fact. Thus, in Jamaica, the author confesses that he was so overcome "by the oppression of the humid heat" that he gazed upon the luxuriance of the tropics "with sullen indifference." But, moving to the north shore, "the Trade Wind blew in strongly from the sea, and the warm, dry, salt breeze was as the breath of life, making me a new man, able to see the beauty of all around." On his second day in the valley of the Rother he found that the flowing river no longer gave him complete satisfaction, until a dipper came into view, bowing, diving and swimming. This changed everything: "the river, the banks, the meadows and the trees all grouped themselves about the stone where stood the dainty, white-throated bird." Some such experience must often have befallen every bird lover. A goldfinch alighting delicately amid snowy cherry-blossom at once heightens the quality of the tree's beauty, and makes perfect a scene already entrancing.

One can imagine a matter-of-fact individual doubting the possibility of his attention being captured and retained throughout some ninety pages of description of natural scenery. But everyone who has some spark of the mystic in his soul will feel the fascination of this beautiful book, and will understand how upon the shores of Ullswater magic began to work upon the poet-author's mind; "the will was shackled; the mystic sense set free, and I wandered in a world where much is seen of which it is hard to tell."

Modern Theatres and Cinemas. By P. MORTON SHAND. (Batsford. 15*s.*).

With this book the publishers inaugurate their "Architecture of Pleasure" series. This is a welcome addition to our somewhat limited literature of the modern theatre and is the best book on theatre construction to be published in this country. Produced somewhat on the lines of Paul Zucker's "Theatre und Lichspielhausen," the book is profusely illustrated with photographs of recently constructed theatres and cinemas, and should appeal not only to those concerned in architectural construction but to all interested in the theatre and the modernist movement.

It is perhaps to be regretted that so little space is devoted to actual stage construction, since after all, with the possible exception of the box office, the stage is the most important part of any theatre. Still, the author is not alone in paying more attention to the auditorium than to the actual mechanics of theatre production, for whenever a new theatre is projected we hear a great deal about the size, shape and comfort of the seats, the particular method of concealed lighting, the colour scheme of the decorations, but little or nothing about the construction of the actual stage. All of which seems to point to the fact that the architect and the manager are primarily concerned with the comfort of the audience; perhaps this is some indication of the reason for the present plight of the theatre.

Mr. Shand chooses to confine his attention to the "front of the house," and he has produced a most attractive and interesting book. The theatres and cinemas illustrated and described are predominantly German, but the author explains that this is more or less inevitable because "their general level is the highest in the world." This we can quite believe if we take as examples the Komodie Theatre, Berlin, and the Universum Kino. One rather wishes, however, that the German influence were not so noticeable in the examples of recent English cinemas, and can only echo the author's wish that, having "as good young architects as any other nation," they should be given a chance. Is it too much to hope that when they get the chance, they should evolve a style of theatre and cinema construction which is British in character.

Matriarchy in the Malay Peninsula and in Neighbouring Countries. By G. A. DE C. DE MOUBRAY. (Routledge. 15*s.*).

No serious student of sociology can afford to neglect this thoughtful and instructive monograph on the customary law which in certain of the Malay States vests ancestral land in the wife rather than the husband. The author explains the local custom in detail, and he also considers the problem in a wider sense with evidence from Malabar and from Sumatra—whence the Malays of Negri Sembilan appear to have migrated. He discusses, too, the fascinating question, so long debated by rival schools of sociologists from Maclennan onwards, whether human society was founded by the women rather than the men. He makes it abundantly clear, at any rate, that matriarchy in Malaya is a stabilizing influence, that it gives the wife and mother an assured position, and thus raises the tone of the whole community.

The custom is being threatened by the influx of Moslem legal ideas which are antagonistic to the *adat* or matriarchal custom, and also by the development of the rubber industry which has given an unforeseen value to land suitable for rubber plantations. The author points out that in many Moslem countries local usages in the holding of land are tolerated even though they are not mentioned in the Koran. He says also that the Government upholds the inalienability of ancestral land, while admitting that land acquired by a family may be sold or bequeathed like personal property. An appendix of legal reports confirms this statement.

This scholarly book is a welcome addition to those which his present and former colleagues in the Malayan Civil Service have written on the peoples of Malaya. An intelligent district officer has special opportunities of studying the habits and usages of the natives among whom he is stationed, and such works as this deserve the warmest encouragement from all sociologists

A Yankee in Patagonia. Edward Chace, his Thirty Years' There. By ROBERT and KATHERINE BARRETT. (Hetter. 12*s.* 6*d.*).

Travelling in Patagonia, the authors met a fellow American who had spent thirty years there. They have made a curiously

interesting book out of his reminiscences of ranching and hunting in the Argentine or Atlantic part of that wild country. Mr. Chace is not another Aloysius Horn. He has too many anecdotes of real life to relate; his reflections on things in general he keeps to himself. He knew Patagonia before it was well policed and before big land companies had bought up and fenced the interior. In the old days the Indians of Tierra del Fuego were hunted down without mercy; a price was paid for each Indian's nose. Life was cheap in the drinking-booths at the settlements, but Mr. Chace recalls only one murder of a settler's wife and in that case the criminals were tracked to their refuge on the Chilean border and shot by an energetic Argentine policeman, who had left his uniform at home.

Mr. Chace has much to say about sheep-rearing. He asserts that with three exceptional dogs he by himself once rounded up ten thousand sheep. When the dogs go wild, as sometimes happens, they commit great ravages on the flocks before they can be shot. It is sad to learn that reckless persons, who had presumably never heard of Australia's sufferings, introduced Belgian hares and white rabbits into a country that was free from them, with the result that large districts have been rendered useless for grazing.

The Book of the Microscope. By GERALD BEAVIS. (Sampson Low. 6s.).

This book is intended primarily for the student, and the aim is to show how the more simple types of apparatus may be made the most use of. Chapters dealing with the telescope in its more interesting aspects are included.

The improved and cheapened apparatus obtainable in recent years has led to a more widespread use of the microscope among beginners, more particularly in the study of botany, the exploration of the sea shore and the examination of insect life. The author shows how the student may make his own instrument and describes the limitless field in which the microscope may be employed. In later chapters he deals with the marvels of coral, pond life, mycetozoa, frost and snow, seed germination and insect and plant life. Hints on photo-micrography are included. The book is an effective introduction to a fascinating study, and might well be used to augment the less entertaining but more detailed textbooks on the subject. There are over a hundred illustrations.

A Short History of Atomism. By J. C. GREGORY. (Black. 10s. 6d.).

The history of atomism may from one point of view be regarded as the history of science in general. It has also been more or less intimately bound up with the history of philosophy; hence, perhaps, the necessity for a history of atomism. For Lucretius atomism was the universe. There were ponderable atoms in a void and nothing else. The differentiation of matter was caused by the swerving of atoms and the ability they possessed in some cases of holding on to each other by means of hooks, as, for example, in iron; other atoms were smooth and easily slipped over each other as in liquids. Atomism was not a branch of science, it was a cosmic philosophy.

In this book the author traces in considerable detail the various modifications in atomic conception through the ages. As a chemist he naturally emphasizes the chemical aspect of the subject, and the chapters dealing with Dalton's theory and Molecular Structure are particularly good. The final chapters deal with modern physical science, and although they present an interesting resumé of the development of theory concerning the structure of the atom, they are too technical to be of real value to the non-scientific reader. On the other hand, the professional physicist will learn very little from them.

As a history the book is too specialized and consequently is in danger of degenerating into a catalogue of events lacking general perspective, but this is a fault inherent in this particular type of book and must not be allowed to take away from the credit that is due to the author for the painstaking and thorough manner in which he has performed a difficult piece of hard work.

Journals of Gilbert White. Edited by WALTER JOHNSON. (Routledge. 21s.).

All who know "The Natural History of Selborne" will be truly grateful to Mr. Johnson, to the editors of the "Broadway Diaries" and to the publishers for having at long last put Gilbert White's diaries into print. The MS. volumes in his neat hand, covering the years from 1768 to 1793 when he died, have lain in the British Museum for half a century, and it was high time that their contents were made accessible to the many quiet people who share White's love of gardening and birds and all the other delights of the countryside.

The author of this book, who had already written a memoir of the naturalist, proves himself a most competent editor. He has wisely refrained from printing everything, for many of the day-to-day entries were necessarily trivial. But what he has printed is in the main readable and instructive, and even the entries that had substantially appeared in the "Natural History" of 1789 are none the less interesting now that we see them in their original form and context. The journals were not needed to prove that White was a patient and accurate observer. He could not have written his classic book without accumulating through many years this store of facts and dates. But the daily notes help to fill in the background of the gentle scholar's life in his beloved Hampshire village, varied by journeys to Oxford or London or the Sussex farms on which he kept an eye, and enlivened by visits and letters from his kinsfolk out in the great world.

This brief memoir and the historical account of the journals are excellent, and the photographic illustrations, with two maps of Selborne parish, are first-rate. The book is a delight in itself, and it will give many of us a fresh excuse for re-reading the greater book that came out of it.

Lagooned in the Virgin Islands. By HAZEL EADIE. (Routledge. 10s. 6d.).

The author relates how she came to the "treasure island" of Tortola in the Caribbean Sea, how she made her home in a hut overlooking a lagoon, and numbered the pelican among her unusual neighbours. Travelling on foot through the "bush-guarded mountains," Miss Eadie encountered many interesting experiences, and her adventures in a fragile craft on shark-infested seas are vividly described. Quaint island customs are dealt with, while other chapters relate the author's social and educative work among the children of the bush. The book contains eight plates by William Johnstone which are good of their kind, and a rather untidy map.

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